No. : SM-E3248-0A

Date: September, 1981

SERVICE MANUAL

MARINE RADAR

MODEL 1600

FURUNO ELECTRIC CO., LTD.

NISHINOMIYA JAPAN

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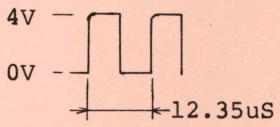
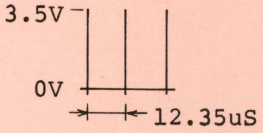
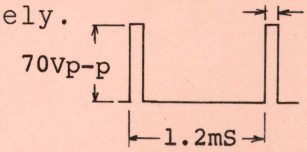
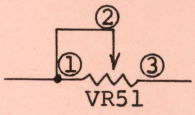
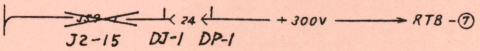
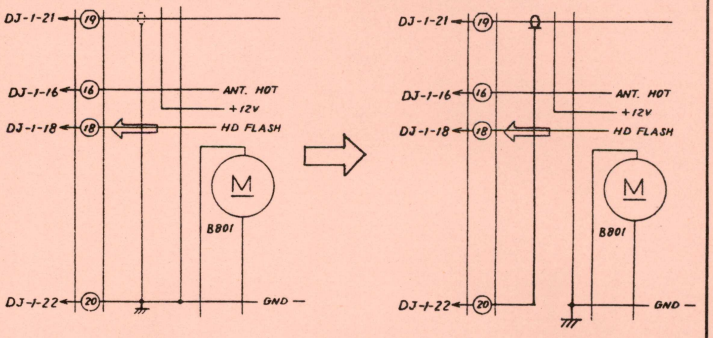
ERRATA TO MODEL 1600 RADAR SERVICE MANUAL (SM-E3248-0A), CIRCUIT DIAGRAM DWG. NO. C3248-007-A.

Unit/Address Reference	Details of Amendments
Display Unit / B-2	Amend the period at TP102 to read "12.35uS". 
Display Unit / B-3	Amend the period at TP301 to read "12.35uS". 
Display Unit / B-4	Amend the voltage and interval at TP107 to read "70Vp-p" and "62uS", respectively. 
Display Unit / C-5	Amend the type of VR51. VR51 is not preset pot., but front panel pot. 
Display Unit / C-7	Amend the destination of +300V line to read "J2-15", i.e. +300V line is running from J2-15 to RTB-7. 
Scanner Unit / D-1	Amend the circuit as follows. 
Scanner Unit / D-5	Amend the name of circuit to read "F-V CONVERTER".
Location of Preset Pot.	Amend the check item at TP108 on DU-4262 to read "THRESHOLD".

FURUNO

Information

No. : FQ3-81-013 (1/2)

Date : 21st. Sept., 1981

Issued by : FURUNO ELECTRIC CO., LTD.
QUALITY CONTROL DEPARTMENT

設計変更一覧表 LIST OF MODIFICATIONS

機種 MODEL	ブロック名 CIRCUIT	記号 SYMBOL	新部品 NEW PARTS 型名/規格 NAME/SPECIFICATIONS	新部品 NEW PARTS コード番号 CODE NO.	旧部品 OLD PARTS	実施時期 SERIAL NO. DATE	変更理由/備考 OBJECT/REMARKS
MODEL 1600	Display Unit DU-4262	CR104	1S2462	000-113-090	1S1588	1981-7	Diode is over-loaded during 0.1uS when turning FUNCTION switch ON.
	Scanner Unit MD-4171	PCB	MD-4171-5	003-037-550	MD-4171-4	1981-7	Magnetron mean current check terminals TP801 and TP802 are mounted on PCB. See Fig.1.
	Display Unit DU-4262	CR108	05Z5.1X	000-110-804	05Z5.1L	1981-7	Specification changed by manufacturer. New and old parts interchangeable.
	Scanner Unit IF-4435	CR607	05Z5.1X	000-110-804	05Z5.1L		
	Scanner Unit Mechanical Parts	Installation Materials	Safety lanyard Label *7* Metal Fitting	300-330-020 300-402-070 000-570-342	Added Added Added	1981-8	To keep radome with safety during field service. Refer to F/I No. FQ3-81-009 dated 29 July, 1981.
			Waterproof sponge 03-003-3212-0	300-332-120	Added	1981-8	To prevent water from intruding into radar mast and/or bridge. Refer to F/I No. FQ3-81-009 dated 29 July, 1981.
	Display Unit PT-4261	R7 R8	ERG-1ANJ101 100ohms, 1W	000-371-240	ERD-25TJ101	1981-9	To protect resistor from running hot.
		K1	MR31-12D	000-454-079	MR31-12	1981-10	To enhance reliability.
	Scanner Unit Mechanical Parts	A122 A147	RADOME FIXTURE *1* 03-003-3102-2 FIXING BOLT 03-003-3203-2	300-331-022 300-332-032	03-003-3102-1 03-003-3203-1	1981-11	Dimensions changed. See Fig.2. NOTE: New A147 and old A122 cannot be paired. Pair of old A147 and new A122 is OK.

⑧ ⑦ ⑥ ⑤ ④ ③ ② ①

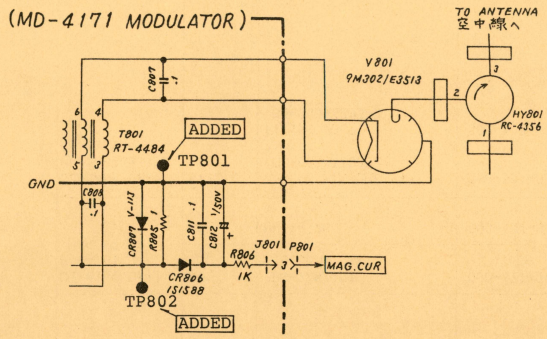
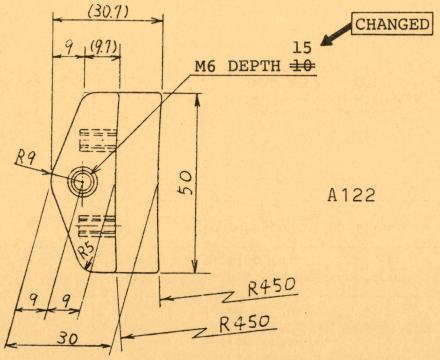

(MD-4171 MODULATOR)
TO ANTENNA
空中線へ
V801
9M302/E3513
HY801
RC-4356
T801
RT-4484
ADDED
TP801
GND
C807
.1
C808
.1
CR807
V-113
R805
1
C811
.1
C812
1/50V
R806
1K
J801
P801
MAG.CUR
CR806
1S1588
TP802
ADDED

Fig.1


(30.7)
9
(9.7)
CHANGED
15
M6 DEPTH ~~10~~
R9
50
A122
9
9
30
R450
R450

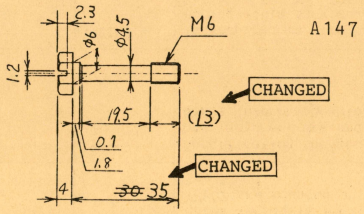

2.3
φ6
φ4.5
M6
A147
1.2
CHANGED
19.5
(13)
0.1
1.8
CHANGED
4
~~30~~ 35

Fig.2

* * * CONTENTS * * *

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SPECIFICATIONS OF MODEL 1600 RADAR

SCANNER UNIT

Radiator	80cm center-fed slotted waveguide array, enclosed in radome
Radiator Rotation	24 r.p.m.
Wind Load	Relative wind 100 knots
Horizontal Beamwidth	2.7°
Vertical Beamwidth	25°
Sidelobe Attenuation	Within ±20° of main lobe ; 21dB Outside ±20° of main lobe; 25dB
Polarization	Horizontal
Ambient Temperature	-25°C to +70°C

RF TRANSCEIVER (Contained in the radome)

Transmitter Tube	9M302/E3513
Frequency	9410 ± 30 MHz (X-band)
Peak Output Power	3kW

Pulselength and Pulse Repetition Rate

RANGE	½, 1, 2	4, 8, 16	n.m.
P/L	0.08	0.5	usec.
P.R.R.	3200	800	Hz

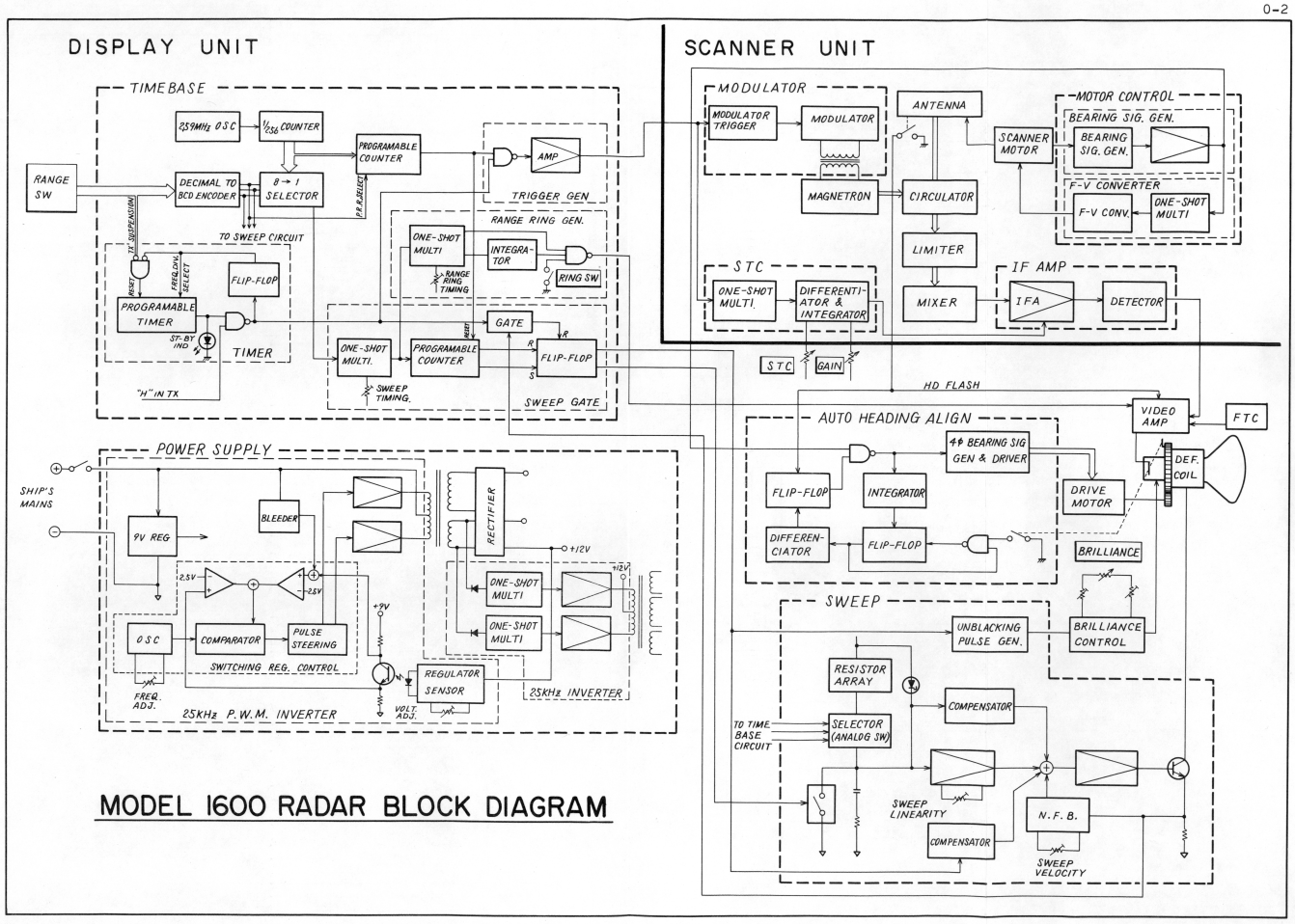
Intermediate Frequency	40 MHz
Bandwidth	7 MHz (with P/L 0.08usec) 3 MHz (with P/L 0.5usec)
Duplexer	Circulator and diode limiter
Modulator	Solid state
Tuning	Manual

DISPLAY UNIT

Picture Tube	7" PPI Scope (12" presentation with magnifying lens)
Range Scales	½, 1, 2, 4, 8, 16 n.m.
Range Ring Interval	1/8, ¼, ½, 1, 2, 4 n.m.
Range Discrimination	Better than 25m
Range Accuracy	1.5% or 70m, whichever is the greater
Minimum Range	25m
Ambient Temperature	-15°C to +55°C

POWER SUPPLY

10.2 to 40VDC, 45W, directly
100/110/115/220VAC ±10%, 50 to 60Hz,
1ø, 70VA, with extra rectifier unit.



MODEL 1600 RADAR BLOCK DIAGRAM

CHAPTER 1. CIRCUIT DESCRIPTION

DISPLAY UNIT

1. Power Supply Circuit

The power supply circuit is made up of 25kHz PWM (Pulse Width Modulation) inverter employing switching regulation technique, 25kHz inverter driven by the output of PWM inverter, and protector. The 25kHz PWM inverter operates universally on ship's mains of 10.2 thru 40V. Against the variation of the mains voltage, it regulates the output DC line voltages by changing width of its output pulse. The 25kHz inverter is mainly for high tension lines. If high voltages are taken from the PWM inverter, the voltages induced on the transformer secondary windings become very high when the mains voltage is at the highest limit, say, nearly 40V, and the transformer is exposed to the danger of layer short. To avoid this, the high tension lines are separately generated in the 25kHz inverter which is driven by the regulated output of the PWM inverter. The block diagram of the power supply circuit is shown below.

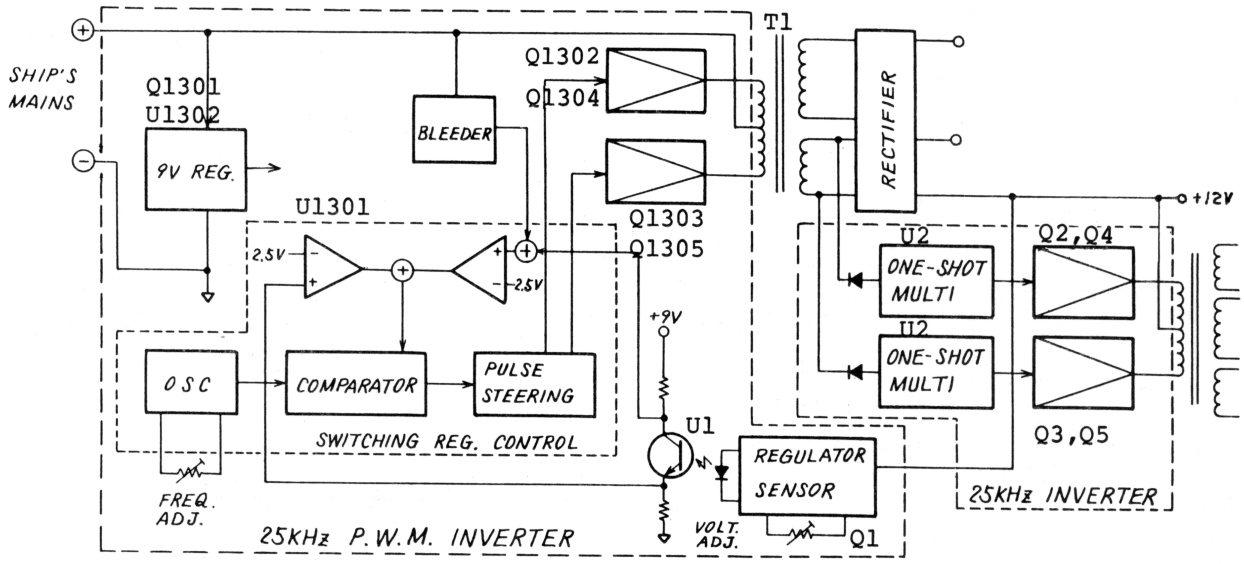


Fig.1-1 Power Supply Circuit Block Diagram

25kHz PWM Inverter

The 25kHz PWM inverter consists of switching regulator control IC U1301, 9V regulator Q1301/U1302, pulse width control circuit U1/Q1, driver Q1302/Q1303 and output amplifier Q1304/Q1305.

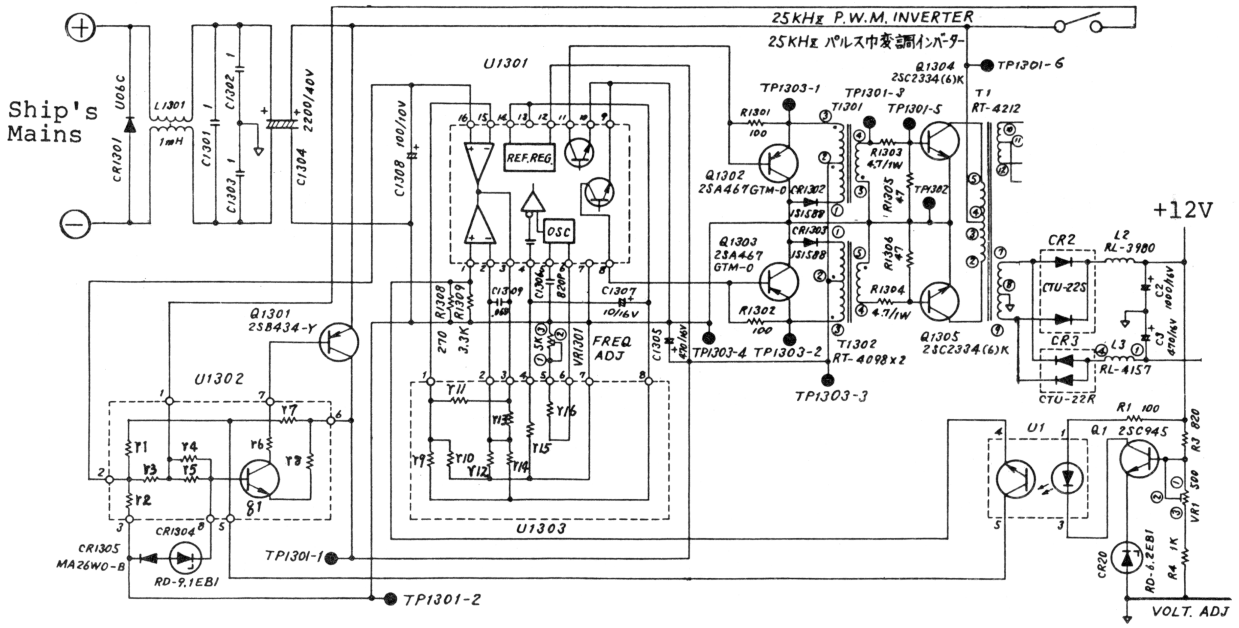


Fig.1-2 25kHz P.W.M. Inverter

Fig.1-3 shows the block diagram of switching regulator control IC U1301 and Fig.1-4, its operating waveform.

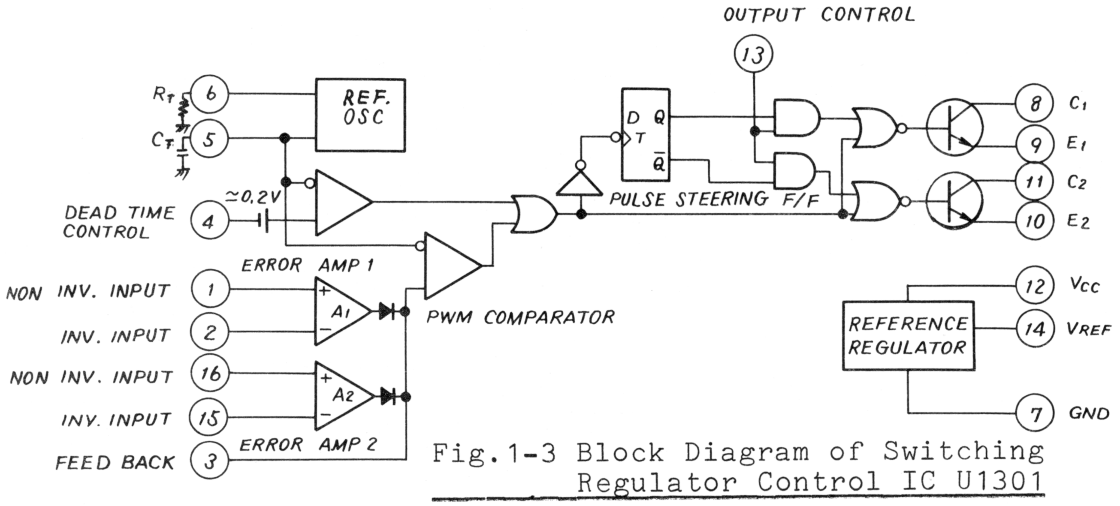
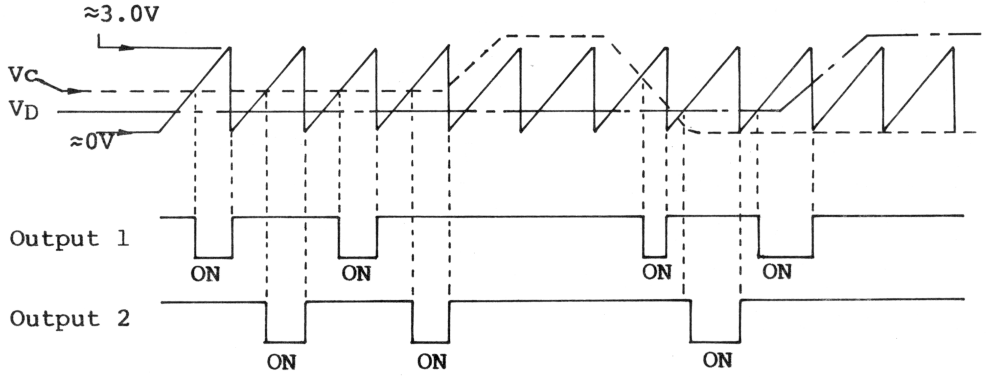


Fig.1-3 Block Diagram of Switching Regulator Control IC U1301



Vc: Output of Error Amplifier V_D: Voltage on Dead Time Control Pin

Fig.1-4 Operating Waveform of Switching Regulator Control IC

The reference oscillator in U1301 is a sawtooth wave oscillator. Its frequency is set by external resistor R_T and capacitor C_T and given by $f=1.2/C_TR_T$. In this radar, it is set to exactly 50kHz by VR1301. The dead time control pin #4 determines a maximum duty ratio of inverter output square wave. In the switching regulator circuit, the dc output line voltages are maintained constant against fluctuation of supply voltage by varying width of output waveform.
However, in case the output stage is in push-pull connection, it is necessary to limit the maximum width of the output waveform so that the width may not become so wide as to drive two output transistors into conduction simultaneously. If the ship's mains voltage drops and the duty ratio of the square wave becomes nearly 50% as in Fig.1-5, the output transistors will conduct simultaneously for a certain period because the transistors have a storage time. In the circuit shown in Fig.1-2, dead time of approximately 2us, which is longer than the storage time of the transistor 1.5us, is provided by pin #4 grounded thru r15.

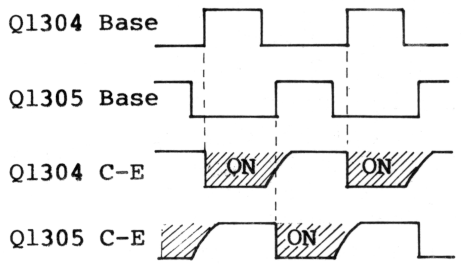


Fig.1-5

C1307 and r15 in U1303 are for starting the 25kHz PWM inverter softly. The dead time control pin #4 of U1301 is fed with time varying positive voltage for about 0.1 seconds after power-on until C1307 is fully charged.

Of the two error amplifiers A1 and A2 in U1301, A2 is used to control pulse width and A2 as a comparator.

The pulse width control circuit shown in Fig.1-6 stabilizes dc output line voltages by moving up and down the slice level for the reference oscillator output sawtooth wave, that is, by converting mains and load variations into the variation of pulse width.

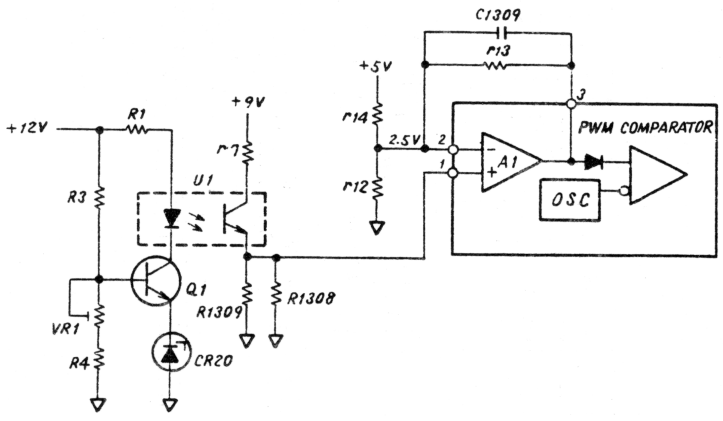


Fig.1-6 Pulse Width Control Circuit

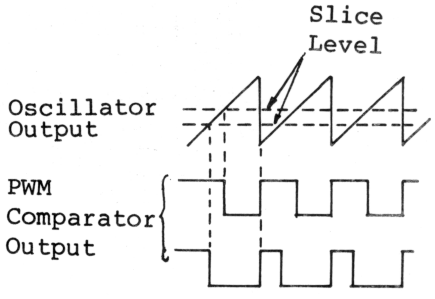


Fig.1-7

The voltage variation on +12V line is detected and fed back to the error amplifier A1 in U1301 via a photo coupler.

The error amplifier A1 has a gain of about 40dB as given by the ratio of r13 to r12/r14 and it is provided with a reference voltage of 2.5V at its inverting input pin. +12V line has been set to 11.6V with VR1 and light emitting diode in U1 is drawing current of about 20mA. If voltage on +12V line changes by some reason, the current in the light emitting diode and then the voltage on non-inverting input pin of error amplifier changes accordingly. The difference of voltage on inverting and non-inverting pins of A1 is amplified 100 times (40dB) and the resultant dc output is fed to the PWM comparator in U1301 to move slice level of sawtooth wave as in Fig.1-7.

The regulated +9V used in the 25kHz PWM inverter is provided by the circuit shown in Fig.1-8. CR1305 is for temperature compensation. It has a temperature coefficient of about -4mV/°C against 4.6mV/°C of zener diode CR1304.

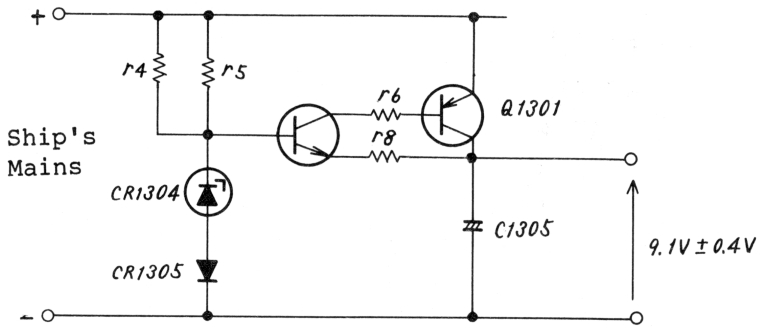


Fig.1-8 +9V Regulator

25kHz Inverter

Driven by the output of the 25kHz PWM inverter, the 25kHz inverter generates +300V for the transmitter, 75V, 25V and 10V for the sweep and +5V for ICs.

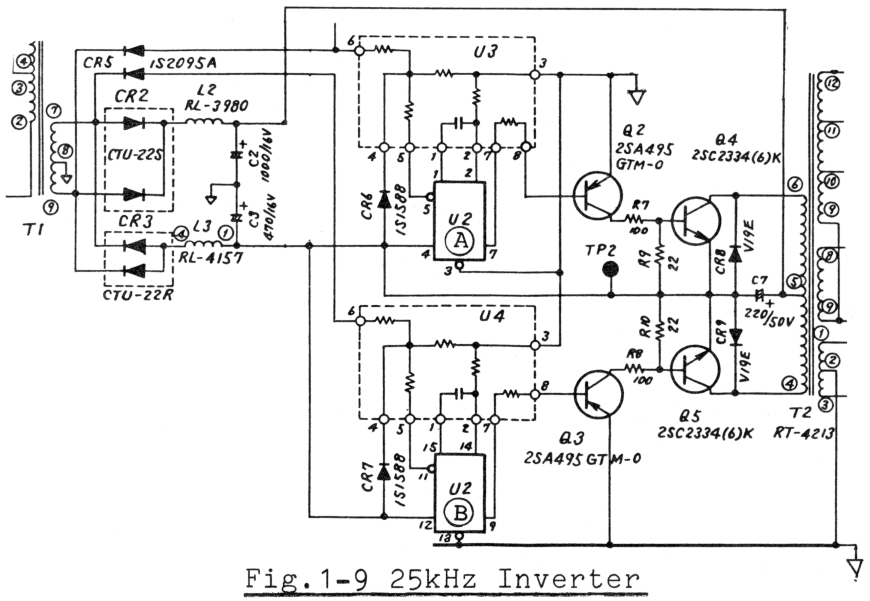


Fig.1-9 25kHz Inverter

Output pulselength of one-shot multivibrators U2(A) and U2(B) is 12us. U2(A) is triggered when tap #9 of power transformer T1 goes negative and U2(B), when tap #7 goes negative. Output pulses of U2(A) and U2(B) are out of phase by 180° each other. They are amplified in Q2 and Q3, and then drive output transistors Q4 and Q5 into push-pull operation.

Protector

The protector circuit shown in Fig.1-10 operates to disable the inverter operation when the following states occur.

(1) When the ship's mains exceeds 45V (mains overvoltage protection).

(2) When one of dc output lines is grounded (output short-circuit protection).

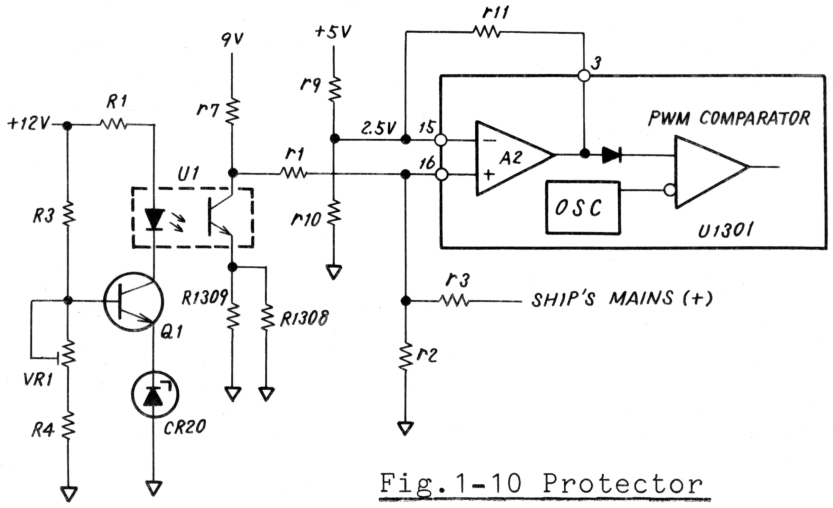


Fig.1-10 Protector

The ship's mains voltage is divided by r3 and r2, and fed to the error amplifier A2 in U1301. Value of r2 and r3 is determined so that the voltage at non-inverting pin of A2 does not exceed 2.5V as far as the ship's mains is below 45V. Then, the output of A2 usually remains negative and exerts no effect on the PWM comparator in U1301.

If the ship's mains rises to 45V, the voltage at the non-inverting pin becomes higher than 2.5V and the output of A2 goes positive. Since the positive voltage is higher than amplitude of the sawtooth wave in the output of reference oscillator, output of the PWM comparator is held "L" at all times and the sawtooth wave is blocked to suspend operation of the inverter.

The protection against shortcircuit of dc output lines is performed by Q1 and U1. If one of the dc output lines is grounded, the voltage on +12V line drops and the current flowing in the light emitting diode of U1 decreases. This results in increase in collector voltage of the photo-transistor over 2.5V, and inverter operation stops.

2. Timebase Circuit

The timebase is the principal part of the radar on which basic operation of the radar depends. The transmitter in the scanner unit and the sweep circuit in the display unit are put into synchronization by the control signals - trigger pulse and sweep gate pulse - generated in this circuit at a recurence rate of 3372pps (≃3400pps) on short range and 843pps (≃800pps) on long range. Further, the timebase circuit determines sweep time on each range, generates range ring pulses and holds down the radar operation for 2'45" at initial power-on for warming-up. The sweep length and range ring intervals are shown in Tab.1-1 and the block diagram of the timebase in Fig.1-11.

Tab. 1-1

Range	Sweep Time	Range Ring Interval	Pulse Repetition Rate
½ n.m.	7.5us	1/8 n.m.	3372pps
1 n.m.	15us	¼ n.m.	3372pps
2 n.m.	30us	½ n.m.	3372pps
4 n.m.	60us	1 n.m.	843pps
8 n.m.	120us	2 n.m.	843pps
16 n.m.	240us	4 n.m.	843pps

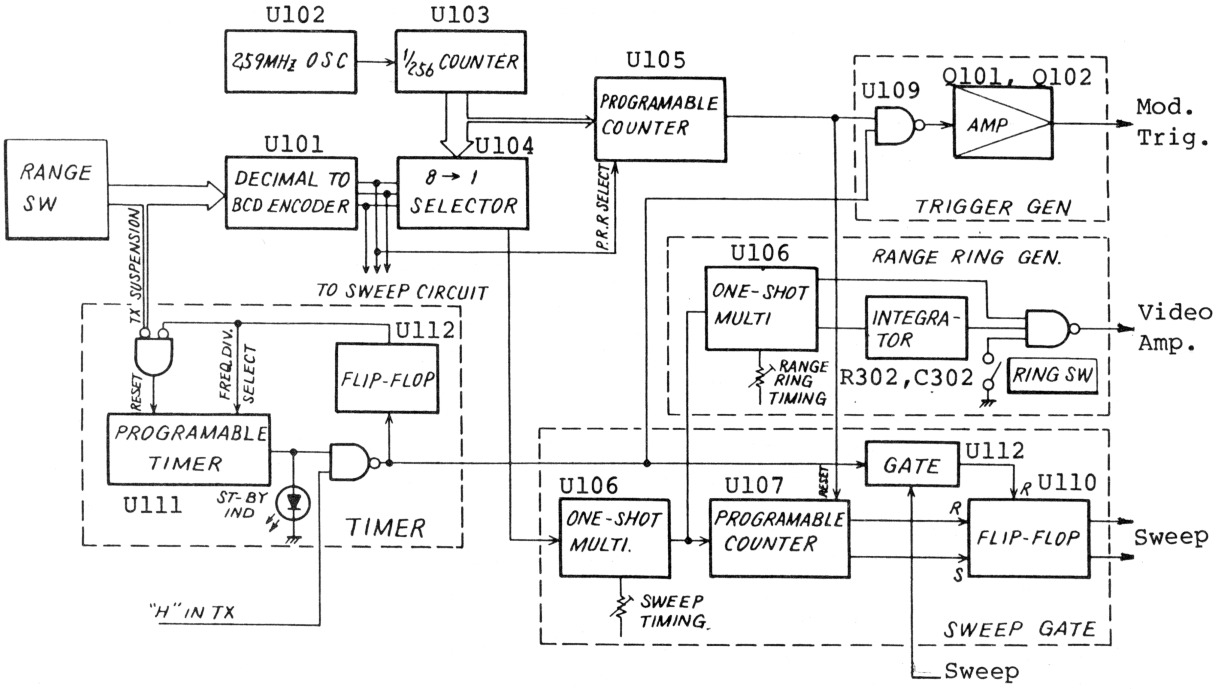


Fig.1-11 Timebase Block Diagram

Pulse Repetition Rate and Trigger Pulse Gen.

Pulse repetition rate of 3372pps on short range and 843pps on long range are determined by the circuit shown in Fig.1-12.

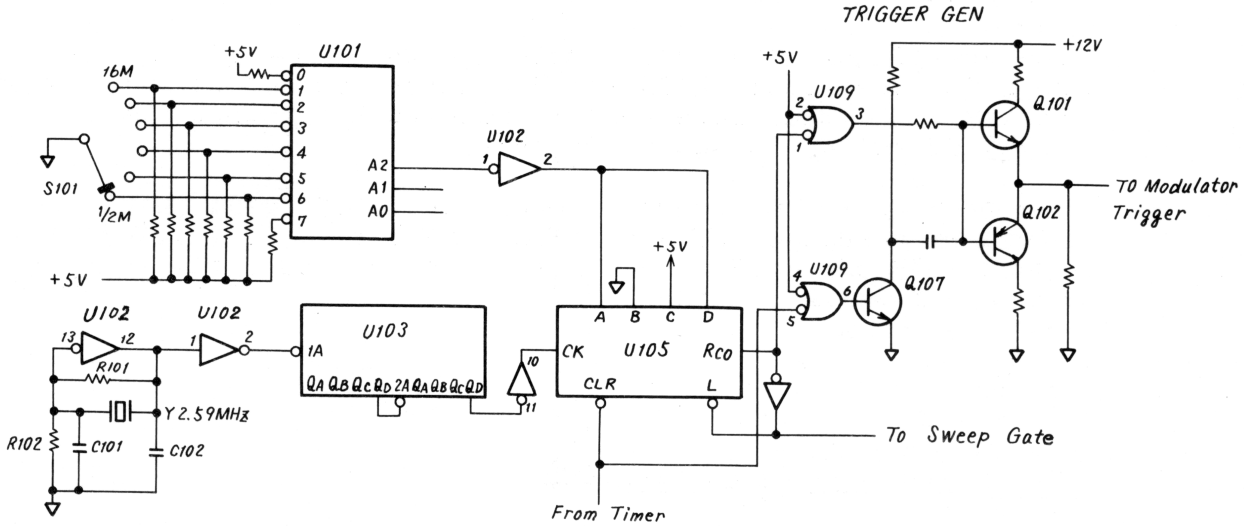


Fig.1-12

U103 is 1/256 counter and U105 is a programable counter that operates as 1/3 counter in short range and 1/12 counter in long range. 2.59MHz signal from the reference oscillator is divided down to 10117Hz by U103 and further down to 3372Hz in short range and 843Hz in long range by U105.

Programing of counting scale in U105 is done at its pins "A", "B", "C" and "D" by range switch S101 connected via U101, a decimal to BCD encoder.
Depending on the logic state on input pins 0 thru 7, it outputs a BCD number to the output pins A0, A1 and A2 as shown in Table 1-2. In the actual circuit shown in Fig.1-12, range switch S101 is connected to the input pins 1 thru 6 in such a way that the pin corresponding to a selected range is grounded.

Tab.1-2 U101 Truth Table

Input								Output		
0	1	2	3	4	5	6	7	A2	A1	A0
L	H	H	H	H	H	H	H	H	H	H
X	L	H	H	H	H	H	H	H	H	L
X	X	L	H	H	H	H	H	H	L	H
X	X	X	L	H	H	H	H	H	L	L
X	X	X	X	L	H	H	H	L	H	H
X	X	X	X	X	L	H	H	L	H	L
X	X	X	X	X	X	L	H	L	L	H
X	X	X	X	X	X	X	L	L	L	L

* X: Either "H" or "L"

Tab.1-3 U105 Truth Table

Input					Output		
Clear	Load	CK	Enable P	Enable T	$Q_AQ_BQ_CQ_D$	Ripple Carry	Operation
H	H		H	H	-	-	Count
H	L		X	X	$D_AD_BD_CD_D$	-	Dat Set
L	X	X	X	X	L L L L	-	Clear
H	X	X	X	H	H H H H		-

On the other hand, since output pin A2 of U101 is fed to preset pins "A" and "D" of U105 via inverter U102, U105 is preset to count 13 in short range and 4 in long range. This results that U105 operates as 1/3 counter in short range and 1/12 counter in long range.

The CLR pin of U105 is connected to the timer circuit and goes "L" to disable U105 for 2 minutes 45 seconds warming-up period at initial power-on. It also goes "L" when the FUNCTION switch is set at "ST-BY".

The trigger pulse generator comprises U109, Q101, Q102 and Q107. It reshapes and amplifies U105 output to a level between 6.8V and 8.7V, and sends it to the modulator trigger generator in the scanner unit.

Sweep Gate and Range Ring Gen.

The sweep gate circuit produces a pulse of which pulselength corresponds to the sweep period on each range, and sends it to the sweep circuit.

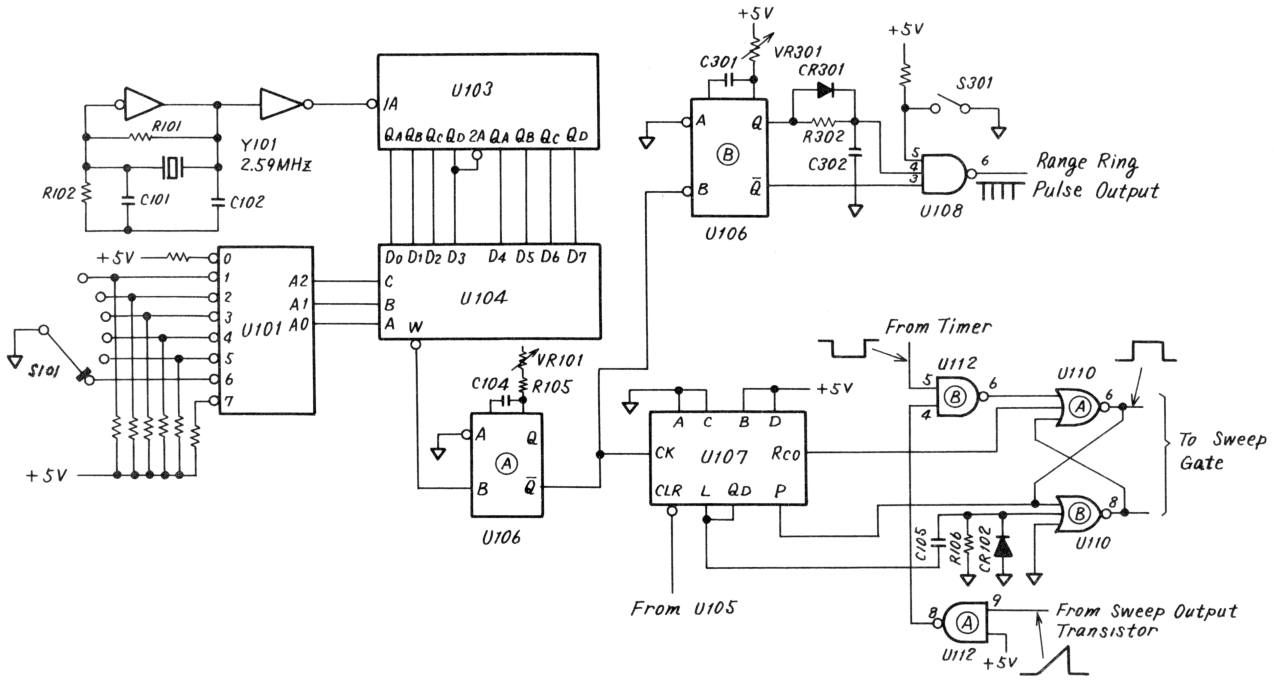


Fig.1-13 Sweep Gate and Range Ring Gen.

Output at respective stages of counter U103 are fed to data selector U104 and one of them is taken out from the output pin "W" according to the RANGE switch setting with its phase inverted. For example, in ½ mile range, input signal on D1 comes out from pin "W". See Tables1-2 and 1-4.

Tab.1-4 U104 Truth Table

INPUT				OUTPUT	
SELECT			STROBE	Y	W
C	B	A	S		
×	×	×	H	L	H
L	L	L	L	D_0	$\overline{D_0}$
L	L	H	L	D_1	$\overline{D_1}$
L	H	L	L	D_2	$\overline{D_2}$
L	H	H	L	D_3	$\overline{D_3}$
H	L	L	L	D_4	$\overline{D_4}$
H	L	H	L	D_5	$\overline{D_5}$
H	H	L	L	D_6	$\overline{D_6}$
H	H	H	L	D_7	$\overline{D_7}$

X: Either "H" or "L".

U106 is a one-shot multivibrator for sweep timing adjustment. It compensates for propagation time in the cable between the display unit and the scanner unit. It is adjusted at installation with VR101 depending on cable length so that the sweep on the screen starts at the moment the leading edge of the transmission leakage signal arrives at the CRT cathode.

Programable 4 bit counter U107 and R-S flip-flop consisting of 2 gates U110A and U110B operate as follows to determine the sweep time which is 5 times as long as wavelength of U106 output.

1) U107 is enabled when its CLR terminal is set "H" by U105 output signal. See Fig.1-14.

2) U107 is pre-set to count 10 on terminals "A", "B", "C" and "D". Thus, when 10th positive going edge of U106A output signal is applied to the CK terminal, its Q_D output goes from "L" to "H". See Fig.1-14.

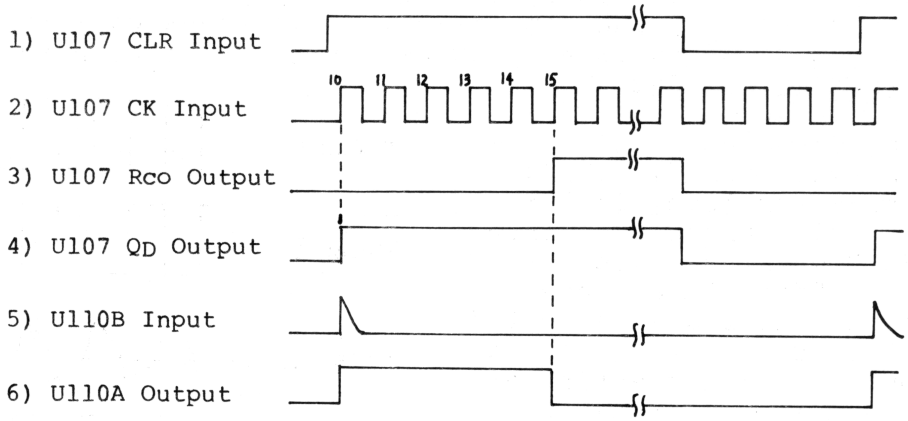


Fig.1-14 Sweep Gate Waveform Chart

3) The "H" output at Q_D is, after differentiated by C105 and R106, applied to the R-S flip-flop and sets U110A output to "H" and U110B output to "L". See Fig.1-14.

4) In succession, U107 counts 5 input signals and stops at count 15 with its carry output pin Rco gone "H". The "H" output at Rco drives the R-S flip-flop into the opposite state.

5) U107 is cleared and disabled when U105 output signal goes "L".

In the above manner, the sweep time equivalent to 5 wavelengths of U104 "W" output signal is provided on U110A and U110B outputs.

The rectangular wave signal fed to the R-S flip-flip thru U112B disables the sweep circuit by driving U110A output to "L" and U110B output to "H" for 2 minutes 45 seconds after power-on and also for 0.6 seconds when the range scale is changed between 2 n.m. (short range) and 4 n.m. range (long range). The signal coming to the R-S flip-flop via two gates U112A and B from the sweep circuit is to protect the sweep circuit output stage. When an abnormal current flows into the deflection coil by some reason, it stops the sweep circuit operation immediately by driving U110A output to "L". While the sweep circuit output stage is normal, peak current of approximately 2A flows into the deflection coil. The circuit is designed to change-over the R-S flip-flop when the peak current reaches to an abnormal level of approximately 3.2A.

The range ring generator made up of U106B, CR301, U108 and associated components receives, from sweep timing adjustment one-shot multivibrator U106A, square wave signal whose wavelength is equivalent to range ring interval and integrates it to produce range ring pulses.

U106B adjusts the timing between the range ring and the sweep. Compensating for delay of range ring pulses in the coupling diode and the video amplifier, it is adjusted with VR301 so that the 1st range ring pulse may coincide with the sweep start on the CRT.

The Q output of U106B charges C302 via CR301 while its level is "H" and discharges C302 thru R302 when the level is "L". Respective range ring pulses are generated at U108 output, having a pulse length starting at the moment Q of U106B goes "L" and terminating at the moment the voltage across C302 drops below input threshold of U108.

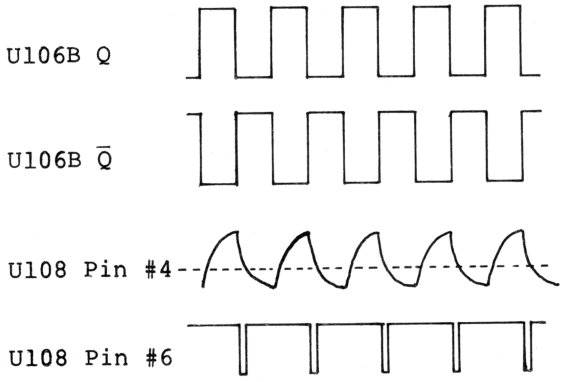


Fig.1-15 Range Ring Gen. Waveform Chart

See Fig.1-15. The theoretical pulselength td is about 130ns as calculated from the following expression.

$$td = C302 \cdot R302 \ln \frac{V_{OH}}{V_{TH}} = 9.54 \times 10^{-8} \ln \frac{4.3}{1.1} \fallingdotseq 130 \times 10^{-9} (s)$$

where V_{OH}= Logical "H" output voltage

V_{TH}= Threshold voltage

Timer

The magnetron must be pre-heated for about 3 minutes before excited by the modulator. In order to ensure this warming-up period, the timer circuit inhibits the operation of transmitter and sweep circuit for 2 minutes 45 seconds after switching on the radar. The schematic diagram is shown in Fig.1-16.

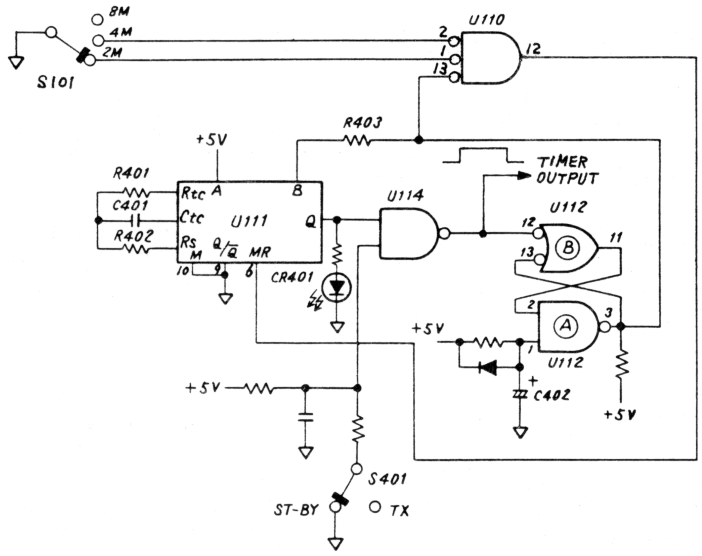


Fig.1-16 Timer

Tabl.1-5 Truth Table of U111

TRUTH TABLE

Pin	State	
	0	1
5	Auto Reset Operating	Auto Reset Disabled
6	Timer Operational	Master Reset On
9	Output Initially Low After Reset	Output Initially High After Reset
10	Single Cycle Mode	Recycle Mode

FREQUENCY SELECTION TABLE

A	B	Number of Counter Stages n	Count 2^n
0	0	13	8192
0	1	10	1024
1	0	8	256
1	1	16	65536

U111 is a programable timer incorporating an oscillator and a 16 stage binary counter, where the counter scale can be controlled as in Tab.1-5 depending on logic states on pins A and B. In the circuit of Fig.1-16, both pins A and B are held "H" after the radar is switched on to use all 16 stages. Fig.1-17 shows the block diagram of U111.

The output Q of U111 goes "H" when the last counter of the 16 stages changes its state, that is, when the 16 stage counter is fed with 32768 pulses (a half of 65536 in Tab.1-5) from the oscillator. Since the radar is considered the required warming-up time has elapsed when the Q terminal goes "H", the oscillator frequency should be set to f=32768/165=199Hz to obtain the 2 minutes 45 seconds warming-up, thus, the frequency is set to 199Hz by external CR network connected to Rtc and Ctc terminals as given by $f=\frac{1}{2.3R401 \cdot C401}$. In addition, since

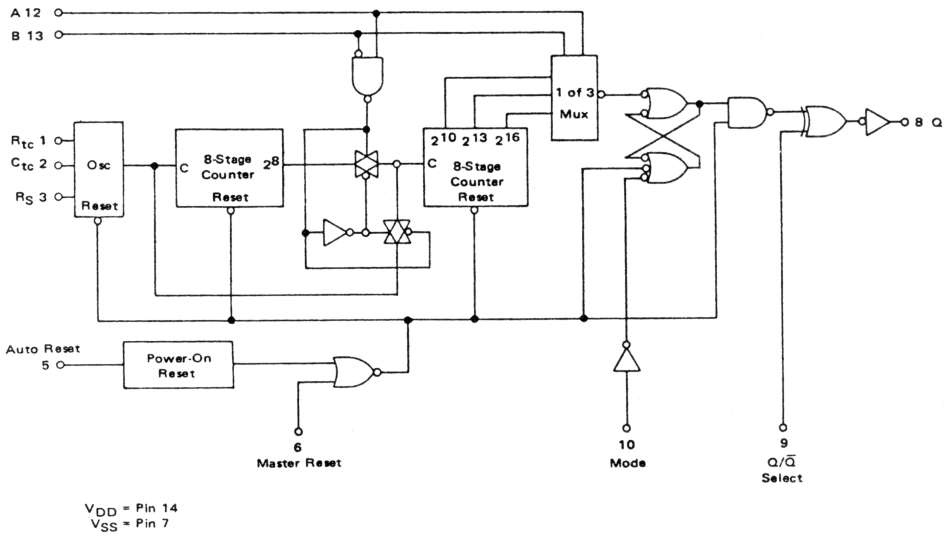


Fig.1-17 Block Diagram of U111

the mode pin "M" is grounded, U111 operates on single cycle mode. Once an output is sent out, the internal R-S flip-flop is locked and no further change occurs.

With the Q of U111 gone "H", if the FUNCTION switch S401 is moved from "ST-BY" to "TX", output of U114 goes "L" and the R-S flip-flop consisting of U112A and U112B is set to "H" in U112B output and "L" in U112A output.

Transmission Suspension

When the range scale is changed from long range to short range or vice versa, the relay in the modulator trips to change the transmission pulselength, and hence the transmission should be suspended for a while (0.6 seconds) to allow for the relay to complete its movement. This is done as follows.

Since RANGE switch S101 is make-before-break type, its 2 and 4 n.m. terminals are instantly grounded simultaneously. This results in U110 output going "H" and U111 being reset with its Q output turned "L". Once U111 is reset, it again becomes operational but since its pin B is "L" now, only 8 stages out of 16 stages are used. This holds the Q output "L" for 0.6 seconds.

3. Sweep Circuit

The sweep circuit is made up of a trapezoid wave generator, deflection circuit and an unblanking pulse generator. The purpose of this circuit is to draw a sawtooth current into the deflection coil.

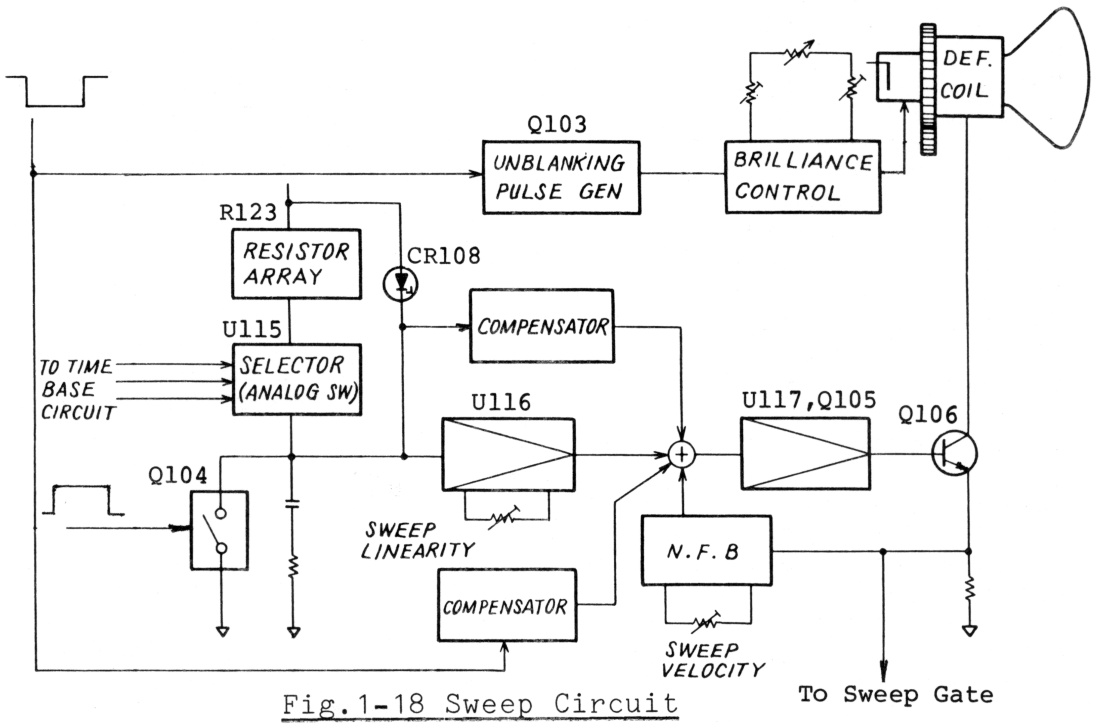


Fig.1-18 Sweep Circuit

Trapezoid Wave Generator

The schematic diagram of the trapezoid wave generator is shown in Fig.1-19.

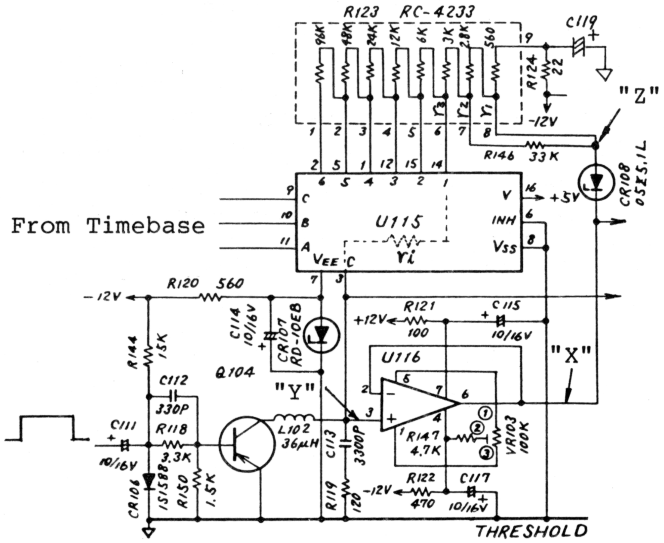


Fig.1-19 Trapezoid Wave Gen.

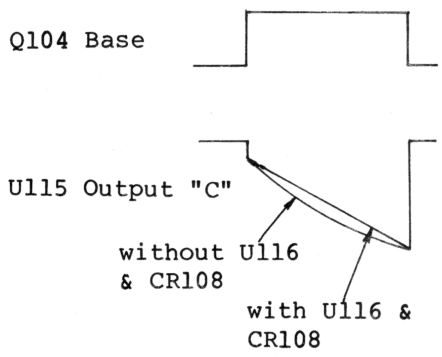


Fig.1-20

To make explanation simpler, first let's neglect operational amplifier U116 and zener diode CR108.

In the stable state, Q104 is in conduction for dc bias fed thru R144, R118 and R150. The potential at pin "C" of U115 is therefore zero and there is no charge in C113.

U115 is an analogue switch called multiplexer. It connects one of input pins #1 thru #6 to output pin "C" as controlled by the logic state on input pins "A", "B" and "C". Since the control signal on pins "A", "B" and "C" is binary number representing range settings and varies as in Tab.1-2 on page 1-7, it is known from Tab.1-6 that output pin "C" is connected to input pin "1" on $\frac{1}{2}$ n.m. range and to "6" on 16 n.m. range. Internal resistance between input and output pins is 60 ohms typically and 220 ohms at maximum.

Tab.1-6 U115 Truth Table

CONTROL INPUTS				"ON"
INHIBIT	C	B	A	CHANNEL
L	L	L	L	0
L	L	L	H	1
L	L	H	L	2
L	L	H	H	3
L	H	L	L	4
L	H	L	H	5
L	H	H	L	6
L	H	H	H	7
H	*	*	*	NONE

"*": Either "H" or "L"

If the square wave shown in Fig.1-20 is introduced to Q104 base in $\frac{1}{2}$ n.m. range, Q104 turns off and the voltage at "C" of U115 drops suddenly to a negative value. The level of this negative voltage is, since there is no charge in C113, determined by the voltage at the junction of C119 and R124, and resistances r1, r2, r3, ri and R119. The voltage then drops further as C113 charges as in Fig.1-20, forming a trapezoidal shape. If this trapezoid wave is amplified and directly used to control the sweep current in the deflection circuit, the sweep trace becomes poor in its linearity. U116 and CR108 improve the linearity by charging C103 by a constant current as follows.

U116 and associated components form a voltage follower. The voltage follower is an impedance translator that features unity voltage gain, high input impedance. Then, the points "X" and "Y" in Fig.1-19 are maintained always at the same potential. Besides, since CR108 is a 5V zener diode, the voltage between points "X" and "Z" is constant at 5V and therefore the voltage between "Y" and "Z" is also constant at 5V. This indicates that while the square wave of Fig.1-20 is present at Q104 base, a constant current flows from "X" to "Y" and C113 is charged at a constant speed, making the slope of the trapezoid wave at "X" and "Y" linear. The peak level of the trapezoid wave is approximately 1.8V on all ranges.

L102 at Q104 collector is for absorbing switching noise of Q104. VR103 is for adjusting offset zero of operational amplifier U116.

Amplifier and Deflection Circuit

The signal coming from the trapezoid wave generator is amplified in the current amplifier of Fig.1-21 and draws a sawtooth current into the deflection coil connected to the collector of the output transistor.

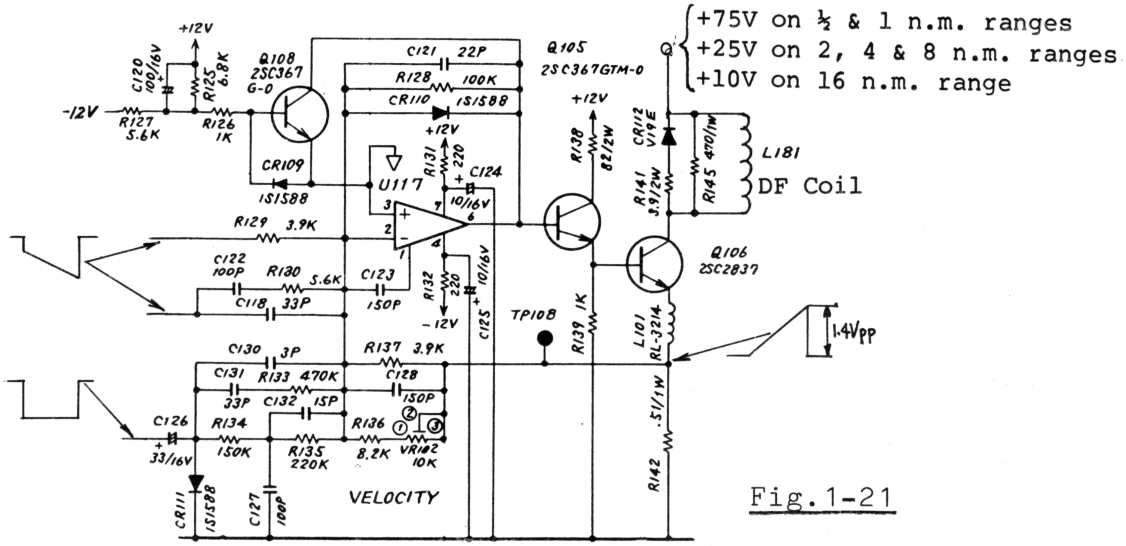


Fig.1-21

U117 is an inverting amplifier with a gain of about 36dB, Q105 is an emitter follower for impedance translation, Q106 is a power amplifier, and these three stages form a feedback amplifier. The total gain of the amplifier is given by the ratio of feedback resistor to the input resistor, i.e. ratio of R137/R136/VR102 to R129. Usually it is adjusted with VR102 so that peak current of 2.8mA may flow through deflection coil L181, that is, so that a sawtooth voltage of 1.4Vpp may develop across R142 (0.5 ohms). In practice, it is adjusted by observing the screen so that the outermost range ring locates just inside the screen edge.

The network consisting of C122, R130 and C118 sharpens the leading edge of the trapezoid wave, compensating for deterioration caused by slew rate of the operational amplifier. The network consisting of C130, C131, R133, R134, C132 and R135 moderates the leading edge of trapezoid wave in short range since above compensation is excessive and it also adds a square wave to the trapezoid wave. In short, it is said that the sawtooth portion of the trapezoid wave is generated by C113 and its square wave portion is set to proper level by R129 and above mentioned two compensators.

CR110 prevents U117 from latching up to -12V which reversely biases Q105 emitter and base. C121 and C123 improve frequency characteristic and C128 prevents parastic oscillation.

Q108 prevents Q105 and Q106 from conducting permanently when -12V is absent from U117 by some reason. If -12V is absent from U117, U117 operates on the voltages 0V - 12V, developing a positive voltage of 2 thru 3V at its output even under no signal condition and leading to permanent conduction of Q105 and Q106. Q108 conducts with -12V absent and grounds Q105 base to prevent this.

R141 and CR112 protect Q106 by absorbing inverse voltage spike which occurs in deflection coil L181 after termination of the trapezoid wave on Q106 base. R145 is a dumper resistor. It suppresses the transient phenomena such as a parastic oscillation or nonlinear rise of sawtooth current that tends to occur on short ranges due to stray capacity around L181. L101 at the emitter of Q106 rejects spike and noise superposed on the sweep drive signal.

Unblanking Pulse Generator

Q103 and associated components form the unblanking pulse generator. It receives the negative going rectangular wave from U108 and sends out a positive going rectangular wave to the grid of CRT thru C503 in order to make the sweep on the CRT visible.

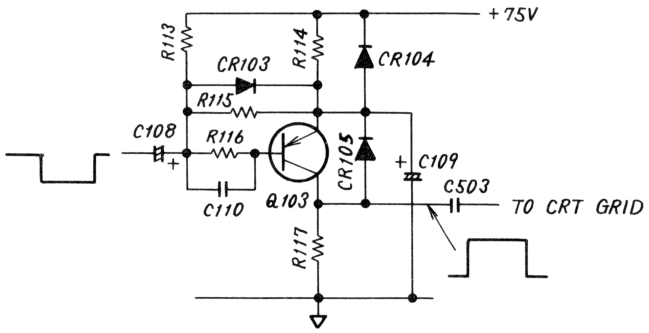


Fig.1-22 Unblanking Pulse Generator

The amplitude of the positive going rectangular wave (unblanking pulse) varies with the range setting so that higher amplitude is obtained on shorter ranges. This is accomplished by varying the emitter potential of Q103 as follows.

Since the smoothing capacitor C109 is provided between Q103 emitter and the ground, the potential on Q103 emitter is a dc voltage which is lower by R114 x (Q103 mean emitter current) than the supply voltage of +75V. Q103 emitter current in mean value is directly proportional to the input waveform, and therefore Q103 emitter potential decreases as the range setting is changed to a longer range. This reduction in the potential at Q103 emitter causes decrease of collector current and lowering of unblanking pulse amplitude.

The purpose of getting the range-varying amplitude is to regulate the CRT brightness without using specific brilliance pre-set on each range.

CR104 provides a discharging path for C109 when the radar is turned off. CR105 prevents the collector to emitter voltage of Q103 from exceeding the maximum rating when an impulse voltage is developed on the CRT grid.

4. Auto Heading Alignment Circuit

The auto heading alignment circuit includes a DF coil drive circuit and an auto heading alignment circuit. Fig.1-23 shows its block diagram and Fig.1-24, schematic diagram.

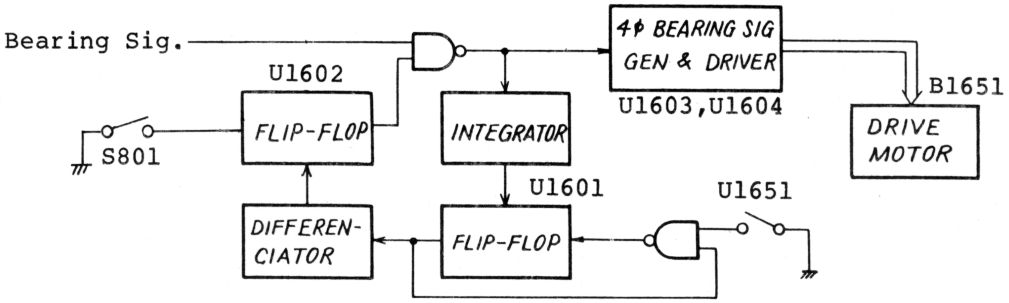


Fig.1-23 Block Diagram of Auto Heading Alingment Circuit

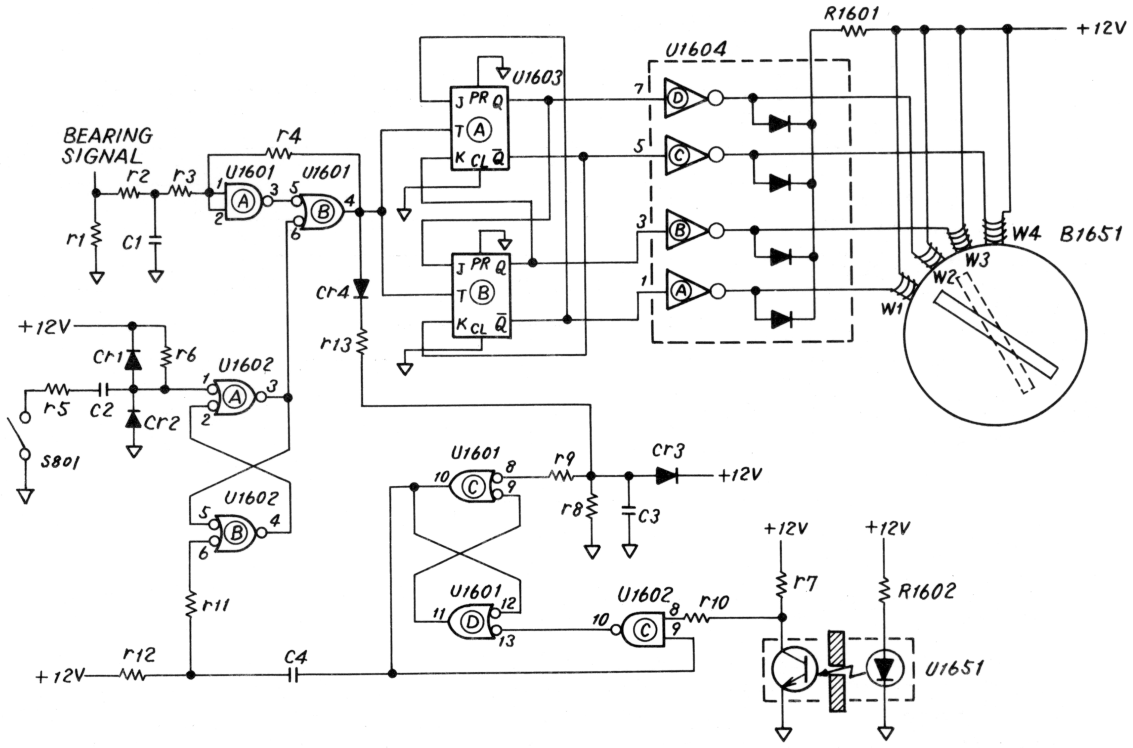


Fig.1-24 Auto Heading Alignment Circuit

DF Coil Drive Circuit

The deflection coil drive circuit receives the bearing signal of 180Hz from the bearing transmitter in the scanner unit and divides it down to 45Hz, 4 phase square wave by 2 J-K flip-flops, U1603(A) & (B). Outputs of the flip-flops are fed thru U1604 to the deflection coil drive motor B1651. The motor rotates at a speed of 225rpm and drives the deflection coil thru the step-down gears (gear ratio 1:9.375) so that the deflection coil rotation is in synchronism with the antenna rotation of 24rpm. How the 45Hz, 4 phase square wave drives B1651 is described below.

Flip-flops U1603(A) and (B) receive the bearing signal thru U1601(A), (B) and produces the 4 phase square wave as shown in Fig.1-25. During the period "1", the output of U1604(A) and (D) is in "L" state. The stator field coils W1 and W2 of the deflection coil drive motor B1651 draw current from +12V line thru U1604, then the rotor comes at the center of coils W1 and W2 as shown in Fig.1-24. In the period "2", current flows to the coils W2 and W3, and the rotor steps to the center of W2 and W3 as shown by dotted line in Fig.1-24. In this manner, driven by the flip-flop output waveforms, B1651 makes a step-by-step rotation. The stator field coils are arranged around the circumference of a circle at 7.5° interval, and 48 pulses are required to make one full revolution.

Diodes in U1604 absorb the inverse electromotive force induced in the stator windings.

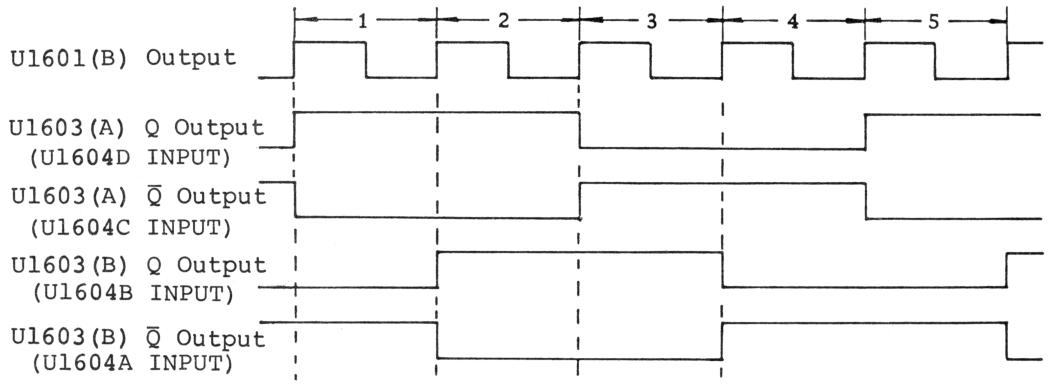


Fig.1-25

Auto Heading Alignment Circuit

The auto heading alignment circuit controls the rotation of deflection coil drive motor B1651 so that the sweep trace on the CRT points in the same direction as the antenna. The circuit consists of U1601(C), U1601(D), U1602(A), U1602(B), U1602(C) and U1651.

Let's suppose that the R-S flip-flop consisting of U1602(A) and U1602(B) is set at a state where U1602(A) output is "H" and U1602(B) output is "L". Let's suppose further that the R-S flip-flop consisting of U1601(C) and (D) is at a state U1601(C) output is "H" and U1601(D) output is "L". Under these conditions, the bearing signal from the scanner unit passes U1601(B) and drives motor B1651.

Photo interruptor U1651 is located above the gear wheel of the deflection coil where a photo interrupting plate is mounted. As the rotation of the deflection coil proceeds and the sweep trace comes to the screen top, the photo interrupting plate intercepts the light of the light emitting diode in U1651 and turns the photo transistor in U1651 off. Output of U1602(C) is then set to "L" and R-S flip-flop of U1601(C) and (D) is set to the opposite state; "L" in U1601(C) output and "H" in U1601(D) output.

Since the R-S flip-flop U1602(A) and (B) also changes the state conversely when U1601(C) output goes "L", gate U1601(B) is closed and the sweep trace stops in the screen top.

The R-S flip-flop U1602(A) and (B) changes the state again to the former state when the antenna faces ship's bow with heading pulse generator S801 in the scanner unit closed. Gate U1601(B) opens its gate and the sweep trace starts rotation.

In this manner, the auto heading alignment circuit brings the heading flash automatically to the screen top.

Once the synchronization is achieved, gate U1602(C) is closed to disable the auto heading alignment circuit. The stop pulse coming from U1651 is blocked at U1602(C) and no further change occurs.

The circuit consisting of cr4, r13, c3 and r8 determines the initial state of R-S flip-flop U1601(C) and (D). It sets U1601(C) output to "H" and U1601(D) output "L" by holding U1601(C) input "L" until c3 is charged up. When the antenna is stopped, the circuit also sets the flip-flop to the initial state in order to resynchronize the heading flash.

5. Video Amplifier

The output from the IF amplifier in the scanner unit is applied to the video amplifier thru coaxial cable. The video amplifier includes FTC, limiter and DC restorer. It has a bandwidth of 18 to 25MHz and the overall gain of about 32dB. In this circuit, video signal of around 1V is amplified up to 40V.

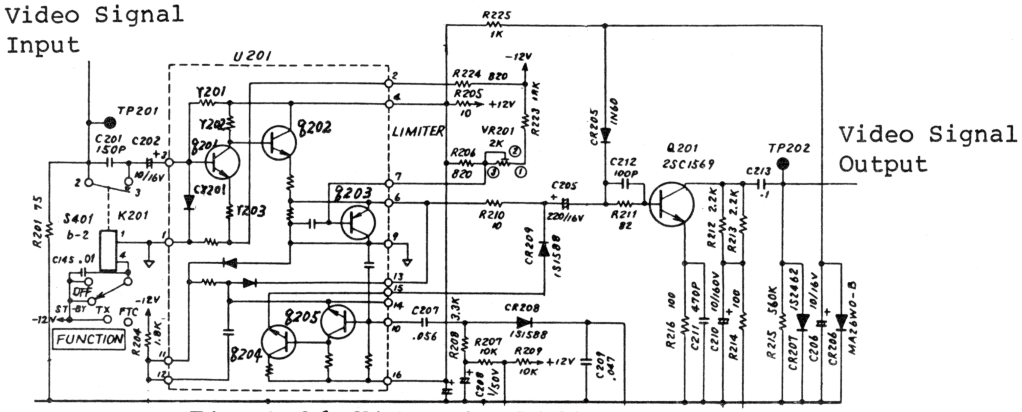


Fig.1-26 Video Amplifier

Fast Time Constant (FTC)

Clutter due to sea returns, rain or snow introduces smeared picture. The FTC function improves target discrimination under these conditions.

With the FUNCTION switch set to TX position, C201 is short-circuited so that q201 in U201 receives the video signal via K201 and C202. With the FUNCTION switch turned to FTC position, relay K201 trips to incorporate C201 into the circuit. The video signal is differentiated by C201, C202 and r203 having a comparatively short time constant, and the resultant negative spike is amplified in the video amplifier. The positive spike corresponding to the trailing edge of the video signal, which otherwise causes a dark spot behind target on the screen, is removed by cr201.

Limiter and DC restorer

In addition to the FTC circuit, the video amplifier contains video limiter which controls the picture contrast on the screen.

Contrast of picture is controlled by varying the base bias of q203. q203 is normally reverse-biased and the signal in the emitter of q202 is led to the base of Q201. If the signal amplitude is high enough to forward-bias emitter-base of q203, q203 conducts and the signal amplitude is limited to the level of q203 base bias.

The output level of the video amplifier is adjusted by VR201 for signal amplitude of 38 to 40V at Q201 collector.

CR207 in the video amplifier output is a DC restorer which removes positive excursions from the video output signal developed across R215.

6. CRT Circuit

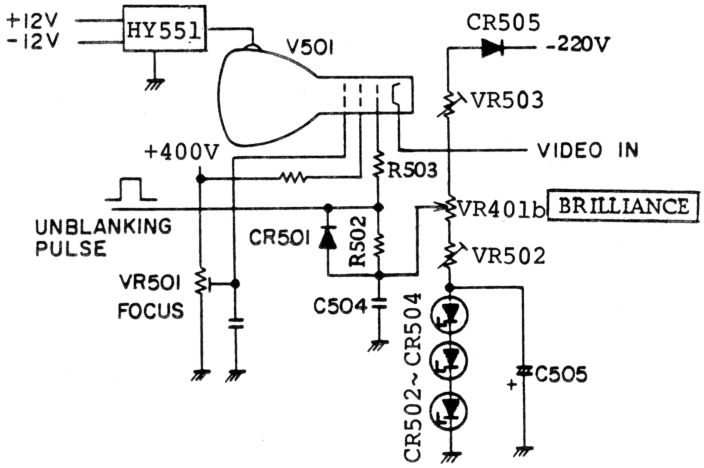


Fig.1-27 CRT Circuit

Unblanking

The positive going rectangular wave developed on the collector of Q103 is DC restored by CR501 and applied thru R503 to the grid of the CRT as an unblanking pulse. With the DC restoring level correctly set by BRILLIANCE control VR401b and brilliance preset controls VR502/VR503, the picture (echoes) becomes visible on the CRT during the unblanking pulse period.

Anti-flash Circuit

The CRT remains hot for some time even after the radar is turned off, that is, the CRT cathode remains warm and is capable of emitting electrons, and also the CRT anode is kept at a high potential due to charge in the voltage multiplier and is capable of accelating the electrons emitted from the cathode. If the CRT grid voltage, negative voltage of about -110V, is removed as soon as the radar is turned off, a large quantity of electrons will be emitted from the cathode and strike the screen center, causing burn of the screen. To avoid this burn, the anti-flash circuit consisting of C505 and CR505 is employed.

Since diode CR505 is provided in -220V line, C505, charged to -99V by zener diode CR502 thru CR504, can not find appropriate discharging path after the radar is turned off.

Discharge can be made only at a slow rate thru back resistance of CR502 to CR504 and therefore the CRT grid potential is maintained for a while negative enough to hold down emission of electrons from the cathode.

Focus

Focusing of picture is accomplished with potentiometer VR501 which varies the CRT focusing electrode voltage between 0V and +400V.

SCANNER UNIT

1. Modulator

The modulator comprises a modulator trigger generator and a modulator. Its schematic diagram is shown in Fig.1-28.

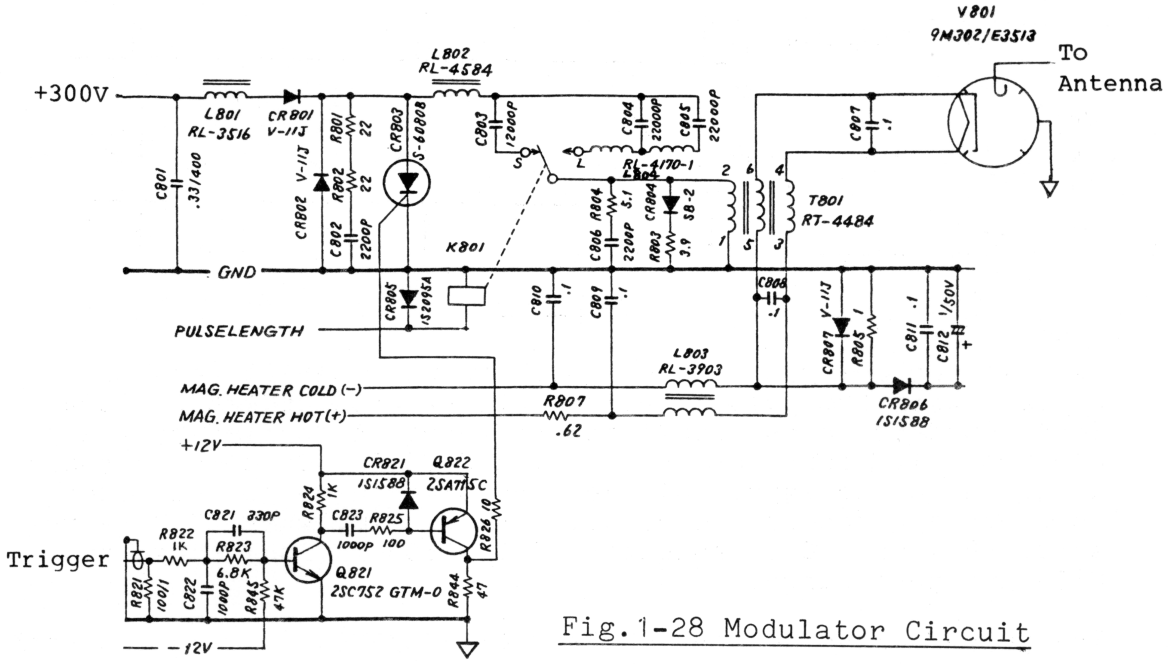


Fig.1-28 Modulator Circuit

Modulator Trigger Generator

The modulator trigger generator is composed of Q821, Q822 and associated components. Receiving the trigger pulses from the trigger generator in the display unit, it produces gate trigger pulse to fire SCR CR803 in the modulator.

In Fig.1-28, Q821 receives the trigger pulses from the display timebase through R822, R823 and C821. With Q821 turned on, Q822 base current flows through R825, C823 and Q821. Then, Q822 conducts and a positive going gate trigger pulse is delivered to the gate of SCR CR803. Since the time constant of C823 and R825 is comparatively small and C823 is charged to saturation in a very short time, the gate trigger pulse obtained is narrow as shown in Fig.1-29. With Q821 cut off, C823 is discharged thru R825, CR821 and R824.

Modulator

The function of the modulator is to produce narrow high tension pulses that drive the magnetron. It is composed of the line-type-pulser as shown in the upper part of Fig.1-28.

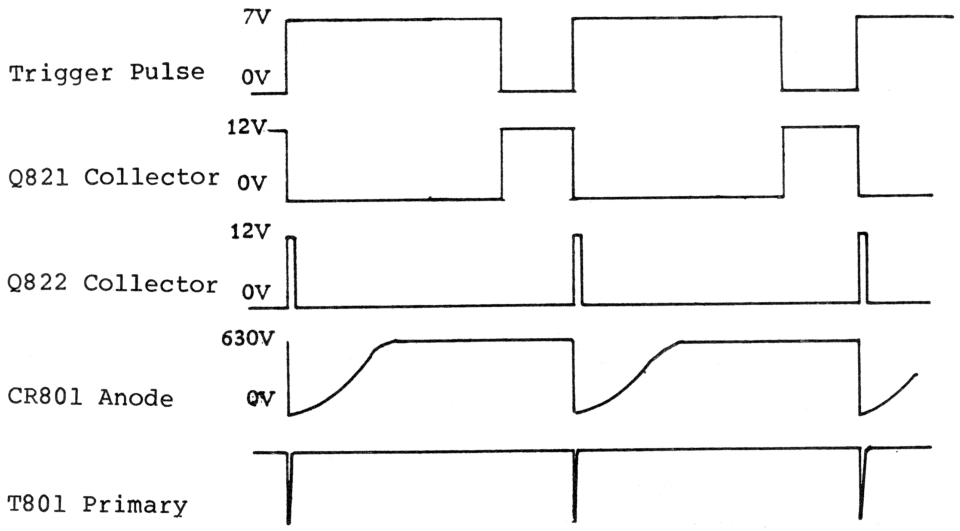


Fig.1-29

L801 is the charging choke, which forms a series resonant circuit with the pulse forming network C803/C804/C805/L804. Three hundred volts (300V) in the input is doubled by the electromotive force of this coil and C803/C804/C805 is charged up to twice the input voltage. The time taken to full charge is roughly given by the equation $T=2\pi\sqrt{LxC}$, where "L" represents L801 and "C", capacitors C804/C805 in long range and C803 in short range.

The pulseforming network C803/C804/C805/L804 is a concentrated constant L-C circuit, which is an application of parallel 2 line circuit with an open end. The modulation pulse that drives the magnetron is developed when the energy in the pulse forming network discharges thru CR803. The duration of the pulse is equal to the time required for the voltage wave to go and return in the L-C network, and it is given by the equation $t=2N\sqrt{LxC}$, where "N" is the number of sections of the L-C network.

CR801 prevents the energy stored in the pulse forming network from discharging to the input line. The advantage of employing CR801 is that it allows a wide choice of CR803 firing timing and efficient utilization of stored energy, that is, CR803 can be fired at any time after the pulse forming network has been charged to peak and fluctuation of trigger timing does not affect the amplitude of the pulse produced.

The pulse transformer T801 boosts up the pulse produced by the pulse forming network. Since the characteristic impedance of the network and the input impedance of T801 is matched, a pulse with half of the network voltage is developed across T801 primary winding. T801 boosts this pulse up by 15 times and applies the resultant output to the magnetron.

L802 holds down the rising speed of CR803 current below a certain level in order to minimize energy loss wasted in the form of heat.

CR804 absorbs the counter electromotive force that is developed at the moment CR803 turns off, protecting CR803 from damage.

Function of CR802 is as follows.
If the modulator load does not match the impedance of the pulse forming network, there will be reflected inverse voltage remaining in the network capacitors after the discharging cycle. At the end of the next charging cycle, the network will be charged to normal voltage level but less the reflected voltage. The action is cumulative and the reflected voltage could cause erratic operation or damage to modulator components. Diode CR802 shuts the pulse forming network to prevent the inverse voltage built-up across the network.

R804 and C806 slow down the rate of rise of the modulator output pulse and prevents developement of spike which may occur due to time log between application of the pulse and the time it takes the magnetron to draw current.

2. Duplexer and Mixer

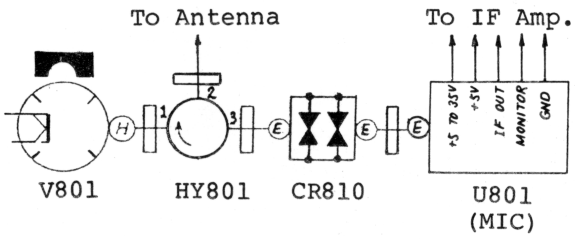


Fig.1-30

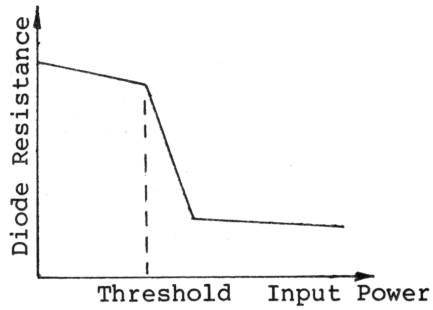


Fig.1-31

Since the radar system uses a single antenna for transmission and reception, an efficient device is required for switching the transmitter and receiver. This radar employs circulator HY801 for this purpose. The circulator HY801 is a passive directional coupler with three ports. It contains a permanent magnet and a core of ferrite material and bends the electromagentic force in a specific direction. In Fig.1-30, the microwave energy produced by the magnetron enters the circulator from port 1. It is bent in the direction of the arrow and emerges from port 2 with little loss, port 3 being isolated. In the same manner, the received signal entering into port 2 is transferred to port 3, isolating port 1. This operation of the circulator protects the receiver during transmission and minimizes loss of the received signal during reception.

The diode limiter is a self-activating switch made of a PIN diode and a varactor diode. Its function is to attenuate strong transmission signal of other boat radars that may enter from the antenna and to protect diodes in the mixer circuit. The PIN diode has a characteristic as in Fig.1-31 and conducts at a certain level of microwave power.

When the diode is in cut-off state, the input impedance of the diode limiter matches the characteristic impedance of the waveguide and the microwave energy is delivered to the mixer circuit. When the diode is in conductive state, the waveguide is shortcircuited and most of the input energy is reflected back to the transmitter side. The strong signal thus attenuated is further weakened down to about 150mW by a varactor diode.

U801 is a microwave IC (MIC) incorporating a local oscillator and mixer diodes. The received microwave signal coming from the diode limiter is mixed with the local oscillation signal in the mixer diodes and converted to IF signal of 40MHz.

3. STC Circuit

The STC circuit made up of U603, Q606 and Q607 changes the gain of IF amplifier with respect to time so that the gain is minimum at the time of transmission and increases gradually to maximum gain.

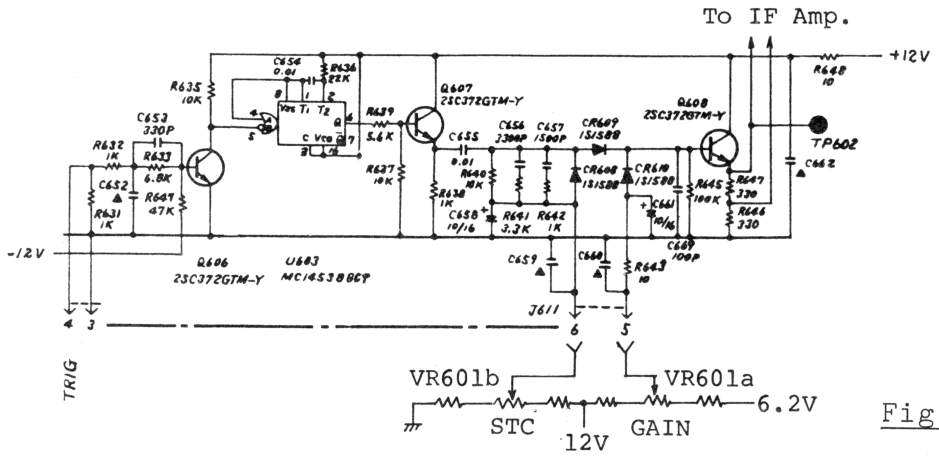


Fig.1-32

Input to the STC circuit is the trigger pulse derived from the timebase in the display unit. One-shot multivibrator U603 is triggered by the positive going edge of the trigger pulse and produces a pulse of 240us, driving Q607 into conduction. The positive going pulse output at the emitter of Q607 is differentiated by C655 and R640; the negative spike of the resultant waveform is removed by CR608.

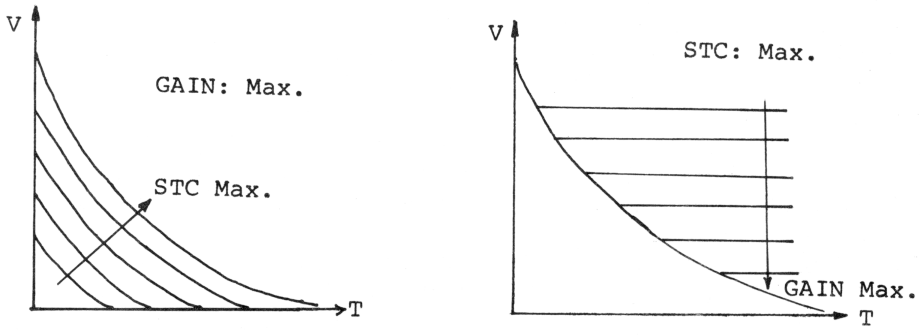


Fig.1-33 Waveform on TP602

The CR network consisting of C656/R641 and C657/R642 is an integrator, each couple having a specific time constant. The network compensates for the differentiator output waveform so that the slower decrease curve may result at the anode of CR609. STC control VR601b slices the compensated waveform at the part below the anode voltage of CR608. Q608 amplifies the resultant waveform and supplies its output to the IF amplifier to suppress the gain. The gain reduction in the IF amplifier is proportional to the amplitude of the waveform, that is, the gain is minimum at the time of transmission and gradually restores to the level set by GAIN control VR601a.

How the STC waveform changes with the STC control setting is shown in Fig.1-33.

GAIN control VR601a changes the base potential of Q608 and Q608 emitter current, and therefore the IF amplifier gain.

4. Motor Control Circuit

The motor control circuit comprises a bearing signal generator and a F-V converter as shown in Fig.1-34.

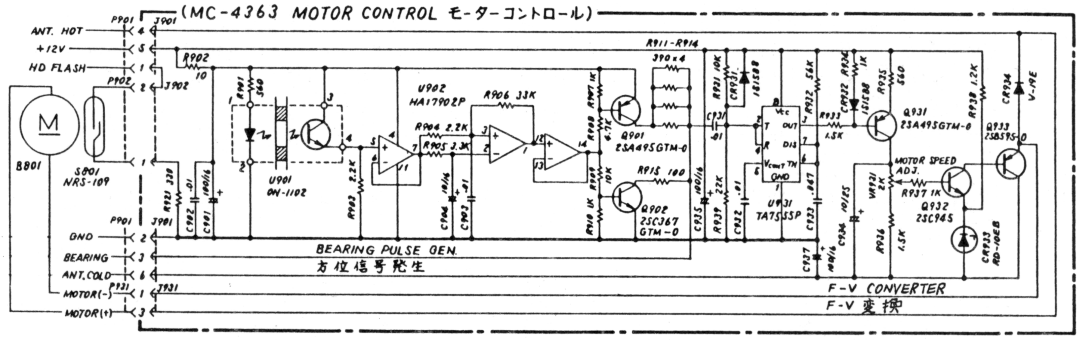


Fig.1-34 Motor Control Circuit

Bearing Pulse Generator

The bearing pulse generator senses the antenna speed by means of a timing disc fitted on the shaft of scanner motor and a photo interruptor mounted near the timing disc, and synchronizes the sweep rotation in the display unit with that of the antenna.

Photo interruptor U901 is composed of a light emitting diode and a photo transistor. It has a configuration in the shape of "U". The light emitting diode is mounted in a wall of "U" shape and the photo transistor in the other wall. Between the two walls is a slit where the timing disc is inserted.

The timing disc is perforated 90 holes at regular intervals along its circumference and rotates at a speed of 120rpm.

The photo transistor receives light emitted by the light emitting diode thru a hole of a timing disc and converts it into electric current. The output of photo transistor across R903 represents a half-rectified since wave with a frequency of 180Hz. This signal is amplified, reshaped and then sent to the display unit to drive the deflection coil drive motor.

F-V Converter Circuit

The F-V converter is made up of U931, Q931, Q932 and Q933.

It maintains the scanner motor at a constant speed by converting the motor speed into a dc voltage and controlling the current flowing into the motor.

U931 is a timer IC, which works in the same manner as ordinary one-shot multivibrator. Activated by every negative going edge of the bearing signal at trigger pin "T", it produces a positve going pulse at pin "3" with a length determined by R932/C933. Since the length of the pulse is always constant, duty ratio of "H" and "L" at the base of Q931 changes as in Fig.1-35. depending on the frequency of the bearing signal. This change in duty ratio leads to the change in dc voltage at the collector of Q931. That is, if frequency of the bearing signal increases, the collector voltage drops, causing decrease in the base current of Q932/Q933 and resultantly the decrease in the current flowing into scanner motor B801. On the contrary, if the frequency decreases, the collector voltage rises and the current flowing into B801 increases.

In this manner, motor B801 is maintained at a constant speed set by VR931.

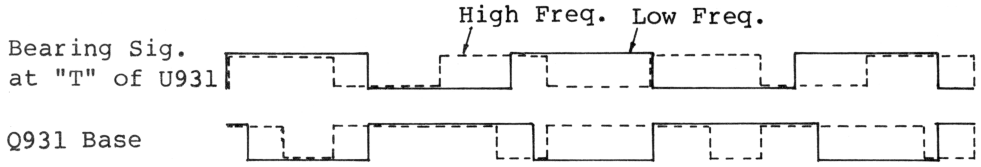


Fig.1-35

CHAPTER 2. ADJUSTMENT

2-1. General

This chapter describes the radar adjustment in a workshop, where various measuring instruments are available. This also helps you with radar setting-up on board in the following cases.

(1) Adjustment at installation (Refer to page 2-11.)

(2) When a major component has been replaced.

(3) When it is considered that a fault is caused by improper adjustment of pre-set controls.

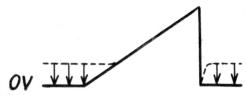
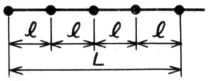
Table 2-1. Measuring Instruments (for servicing on board)

No.	Name	Recommended	Specifications/remarks
1	Multimeter	Sanwa YX-360TR	Vdc: 0.1V to 1000V (25kohms/V) Vac: 10V to 1000V (8kohms/V) Idc: 50uA to 250mA R : 2kohms to 20Mohms
		Sanwa AX-303TR	Vdc: 0.3V to 1200V (20kohms/V) Vac: 6V to 1200V (8kohms/V) Idc: 60uA to 300mA & 12A R : 2kohms to 20Mohms
2	Digital Multimeter	Sanwa 430OTR	Vdc: 2V to 1000V Vac: 2V to 1000V Idc: 200mA R : 2kohms to 20Mohms
		Sanwa 720OES	Vdc: 200mV to 1000V Vac: 200mV to 600V Idc: 0.2mA to 200mA Iac: 0.2mA to 200mA R : 0.2kohms to 20Mohms
3	Oscilloscope	TEKTRONIX 324	Vert: DC to 10MHz, Single Trace, 2mV/div to 20V/div, 500V max. Rise time 36ns Hor : 1us/div to 0.2s/div 0.2us/div min. with x5 sweep 0.5s/div max. with sweep adj. TRIG: Auto/manual, Int/Ext. CRT : 6x10 div (38mmx63.5mm)
4	Non-reflection Termination	FURUNO	Using item 4 and 5, RF transceiver module taken out of the scanner base can be checked beside the display unit.
5	Test Cable	FURUNO	

Table 2-2. Measuring Instruments (for servicing in workshop)

No.	Name	Recommended	Specification/remarks
1	Multimeter	See Table 2-1.	
2	Digital Multimeter		
3	Oscilloscope	TEKTRONIX 324	See Table 2-1.
		TEKTRONIX 455	Vert: DC to 50MHz, Dual Trace, 5mV/div to 50V/div, Hor : 0.05us/div to 0.5s/div 5us/div min. with x10 sweep TRIG: Auto/manual, Int/Ext. CRT : 8x10 div (80mmx100mm)
4	Non-reflection Termination	FURUNO	Using item 4 and 5, RF transceiver module taken out of the scanner base can be checked beside the display.
5	Test Cable	FURUNO	
6	Variable Power Supply	Arrange Locally	Output Voltage: DC8V to DC50V Power Capacity: 350W
7	Frequency Counter	Takeda TR-5104	Freq. : DC to 60MHz Vin : 50mV to 5V Period : 1us to 1000s
		Iwatsu UC-7641	Freq. : DC to 60MHz Vin : 10mV to 20V Period : 0.1us to 10,000S
8	Signal Generator	Matsushita VP-730A	Freq. : 10Hz to 10MHz Vout : 6Vp-p max. (75ohm load)

Table 2-3 Adjusting Points and Ratings

No.	Items	Ratings	Adjuster	Check Point	Refer to
1	Inverter Frequency Reference Voltage	24.75kHz to 25.25kHz 11.68V to 11.92V	VR1301 VR1	TP1303#1 & #4 TP1 #7(+) & #4(-)	Page 2-4
2	Sweep Linearity (Threshold)		VR103	TP108	Page 2-5
3	Range Ring Timing	1/2M & 1M rings should appear at same position.	VR301	CRT Screen	Page 2-6
4	Sweep Centering	Sweep origin is placed at the center of cursor.	Centering Magnet	CRT Screen	Page 2-11
5	Sweep Velocity	L=74±1mm ℓ=L/4±1mm 	VR102	CRT Screen	Page 2-6
6	Video Limiter	Vp=38V to 40V 	VR201	TP202	Page 2-7
7	Receiver Coarse Tuning	The best sensitivity at around mid-travel of TUNING control.	VR402	CRT Screen	Page 2-11
8	CRT Brilliance Focus		{VR502 VR503} VR501	CRT Screen	Page 2-8
9	TX/Sweep Timing	Straight object displayed straight	VR101	CRT Screen	Page 2-11
10	Motor Speed (BG Signal Frequency)	178Hz to 182Hz (23.7 rpm to 24.3 rpm)	VR931	J901#3 & #1	Page 2-8
11	Heading Alignment	-0.5° to +0.5°	S801	CRT Screen	Page 2-11
12	VRM (option) Max Range Min Range	38 n.m. to 42 n.m. 0.00 n.m.	VR2851 VR2852	VRM Display	See VRM RUU-3770 Installation Manual
13	Timing Belt Tension	2.2kg to 2.4kg	S-106	Scanner Driving	Page 2-9

2-2. Inverter Frequency and Reference Voltage

Necessary Test Instruments:

1) Multimeter
2) Frequency counter or well-calibrated oscilloscope

Condition:

Stand-by, 1/2 n.m. range, scanner rotationg, minimum CRT brilliance.

Procedure:

1) Connect the multimeter, set at DC 30V or 50V range, between #7 (+) and #4 (-) of TP1, and the frequency counter or well-calibrated oscilloscope between TP1303 #1 and # 4. See Fig.2-1.

2) With the rated power supply voltage, operate the radar in the above condition.

3) Adjust VR1 to get 11.8V reading on the multimeter. -REFERENCE VOLTAGE ADJUSTMENT-

4) With VR1 adjusted for the reading of 11.8V on the meter, adjust VR1301 so that the frequency counter reads 25.0kHz (40usec in period when measured by oscilloscope). -FREQUENCY ADJUSTMENT-

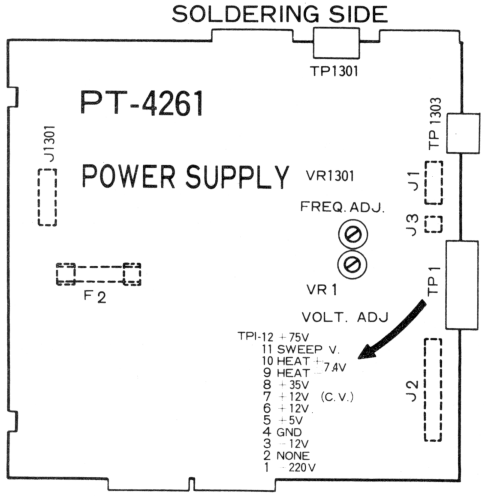


Fig.2-1 POWER SUPPLY PCB PT-4261

2-3. Sweep Linearity (Threshold) Adjustment

Necessary Test Instrument: Oscilloscope

Condition:

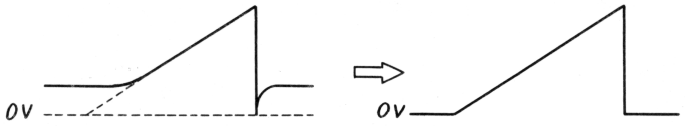
Transmit, fuse F1 (0.5A) removed, 1/2 n.m. range, scanner stopped (F1352 removed), minimum CRT brilliance.

Procedure:

1) Connect the check probe of oscilloscope to TP108, and calibrate the vertical sweep position of oscilloscope with input mode (AC-GND-DC) set at "GND". Then set it to "DC" mode.

2) Set the radar to above condition.

3) Turn clockwise VR103 until the oscilloscope displays a waveform shown in Fig.2-2(a). Then, slightly turn VR103 counterclockwise so that the base line drops to 0V.



a) Bad Setting b) Good Setting

Fig.2-2 Waveform at TP108

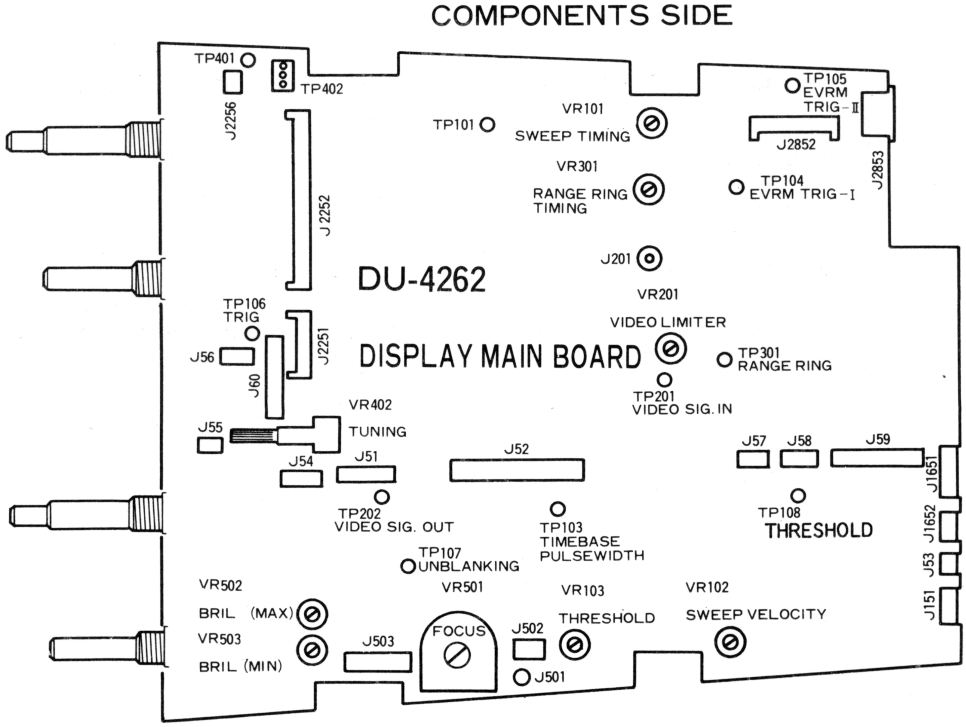


Fig.2-3 Display Main PCB DU-4262

2-4. Range Ring Timing

Condition:

Transmit, fuse F1 (0.5A) removed, scanner stopped, (F1352 removed), BRILLIANCE/RING pulled and adjusted for normal intensity of range rings.

Procedure:

1) Set the radar to the above condition.

2) Adjust VR301 so that range rings at 1/2 appear at the same position on the screen. Refer to Fig.2-3 for the location of VR301.

2-5. Sweep Velocity

Note: This adjustment should be made after "Sweep Linearity (Threshold) Adjustment" and "Range Ring Timing Adjustment" mentioned above have been accomplished.

Necessary Test Instrument: Gauge for Sweep adjustment.

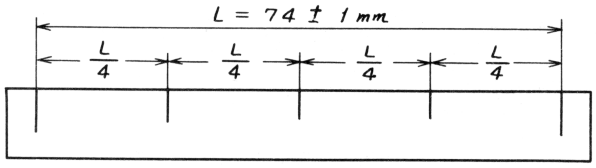


Fig.2-4

Condition: Transmit, F1 (0.5A) removed, GAIN set at minimum.

Procedure:

1) Operate the radar in the above condition.

2) Pull BRILLIANCE/RING knob and turn clockwise.

3) Stop the sweep trace in 90 deg direction by removing fuse F1352. Then, stick the gauge as shown in Fig.2-5.

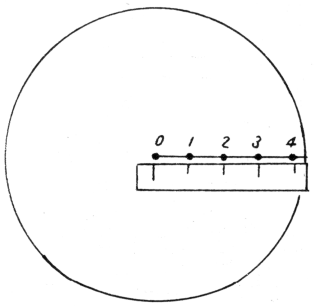


Fig.2-5

4) With the RANGE set to 16 n.m., adjust VR102 (See Fig. 2-3) on the display main p.c.b. so that the 4th range ring (5th spot from center) coincides with gauge line as shown in Fig.2-6.

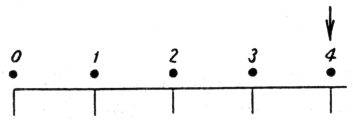


Fig.2-6

2-6. Video Limiter

Necessary Test Instrument: Oscilloscope

Condition:

Transmit, 16 n.m. range, Scanner stopped (F1352 removed), BRILLIANCE/RING pulled and turned fully CCW, GAIN control set to 60% to 80%.

Procedure:

1) Connect the check probe of oscilloscope to TP202 (See Fig.2-3).

2) Set the radar to above condition.

3) Adjust VR201 (See Fig.2-3) so that the negative peak level is within -38V to -40V as below.

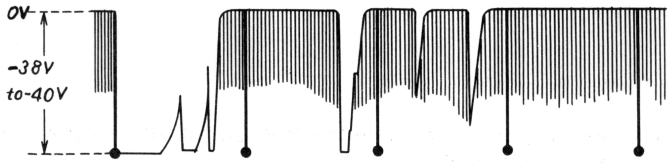


Fig.2-7 Video Output at TP202

2-7. CRT Brilliance & Focus

Condition: Transmit, scanner rotating, GAIN set at minimum, viewing hood fitted.

Procedure:

1) With GAIN set at minimum, set the radar to transmit in 4 n.m. range. Fit the viewing hood on the CRT screen.

2) With VR502 and VR503 turned fully CCW, turn BRILLIANCE control fully CW. See Fig.2-3.

3) Turn VR502 CW little by little until the sweep trace becomes dimly visible on the CRT.

4) With BRILLIANCE/RING pulled and turned fully CCW, turn VR503 gradually CW until the range rings are dimly visible on CRT. Then turn VR503 slightly CCW.

5) With BRILLIANCE/RING turned fully CW, adjust VR502 again so that the sweep trace is faintly visible on CRT.
- CRT BRILLIANCE ADJUSTMENT -

6) Operate the radar for normal picture, and confirm that proper brilliance is obtained on all ranges.

7) Remove fuse F1352 to suspend the scanner rotation. While observing the range ring, adjust VR501 shown in Fig.2-3 so that the range ring spots may be plotted as sharp as possible. -FOCUS ADJUSTMENT-

2-8. Motor Speed (Bearing Signal Frequency)

Necessary Test Instrument: Frequency Counter

Condition: Stand-by, 1/2 n.m. range.

Procedure:

1) Connect the check probe of frequency counter between pin #3 and #1 of J901. See Fig.2-8.

2) Operate the radar in the above condition. Conefirm that the antenna radiator is rotating.

3) Adjust VR931 so that the frequency counter indicates 180Hz.

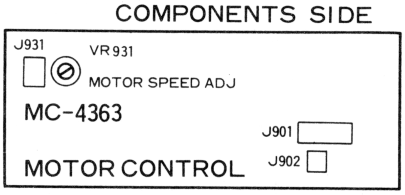


Fig.2-8

2-9. Timing Belt Tension

Necessary Test Instrument:

Tension Gauge. (Spring Type, Max. tension 10kg)

Procedure:

1) Loosen three screws S-106 shown in Fig.2-9.

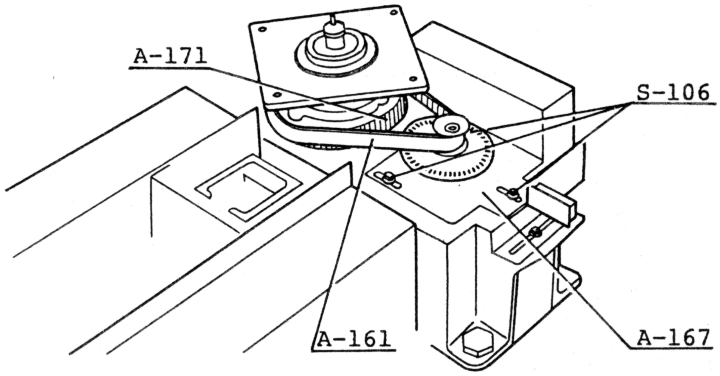


Fig.2-9

2) Hook the tension gauge to the motor shaft as shown in Fig.2-10.

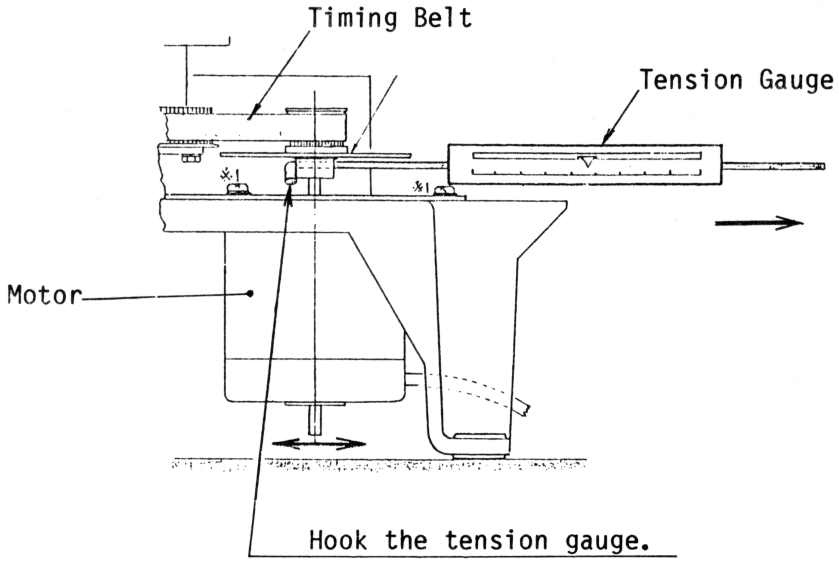


Fig.2-10

3) Pull the gauge until the reading reaches 5kg.

4) Loosen the tension gauge for 2.2kg thru 2.4kg. Then, tighten screws S-106.

TEST CABLE FOR RF TRANCEIVER ASSEMBLY CHECKING

No.	Name	Code No.	Type	Q'ty
1	24P Plug	000-500-160	MCP-24M02 (HOUSING)	1
		000-500-150	MCP-24WS2 (HOUSING)	1
		000-500-162	MCP-M102R (CONTACT)	20
2	12P Plug	000-505-460	LP-12 (HOUSING)	1
		000-505-391	SLF-01T-2.0 (CONTACT)	12
3	15P Plug	000-505-461	LP-15 (HOUSING)	1
		000-505-391	SLF-01T-2.0 (CONTACT)	15
4	Coax. Cable & Lead Wires		Impedance: 75 ohms	Some

NOTE: 1) Do not place the RF transceiver Assembly on the steel desk with the magnetron side down, otherwise it may be deteriorated.
2) Do not operate the RF transceiver module in TRANSMIT condition without connecting the NON-REFLECTION TERMINATION.

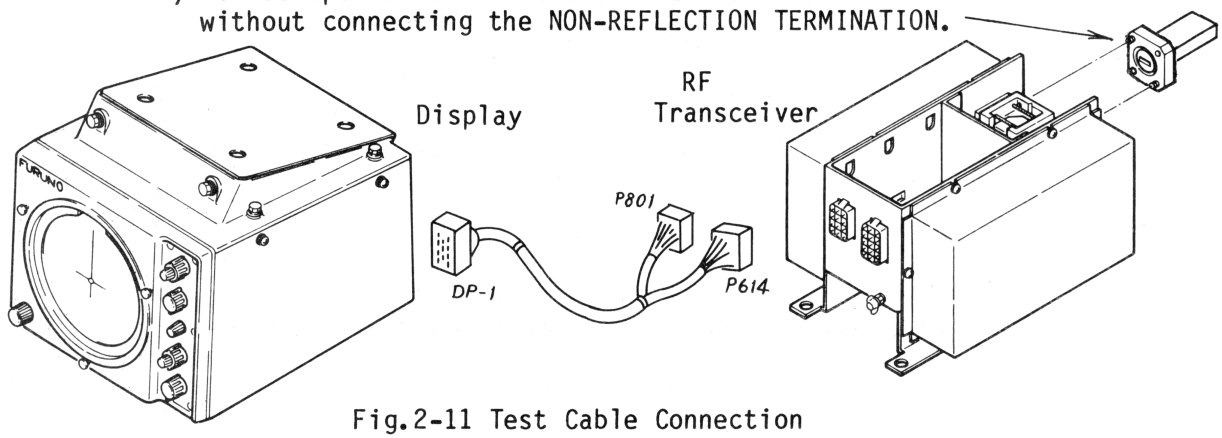


Fig.2-11 Test Cable Connection

Note: Refer to page 3-14 thru 3-16 for Fabrication of connector plugs.

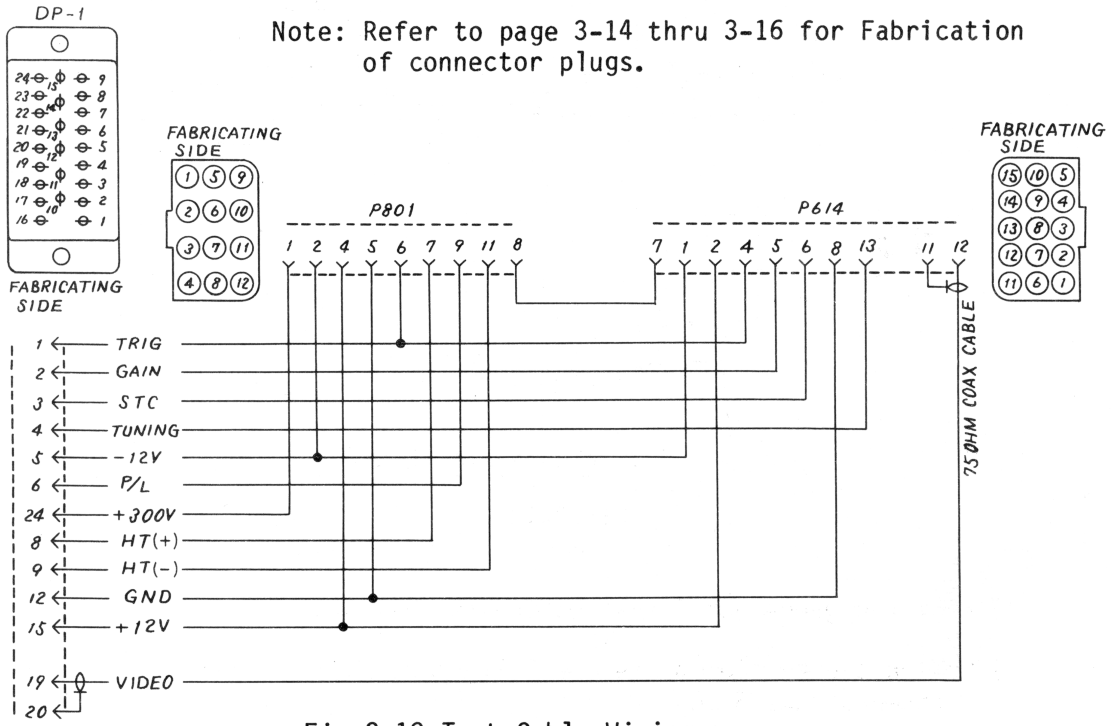


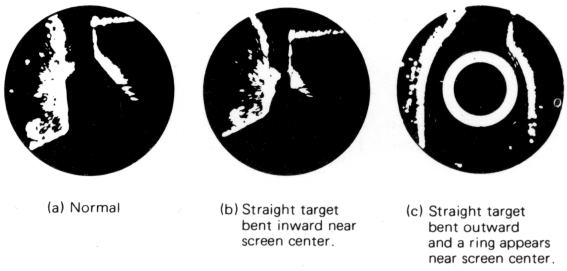
Fig.2-12 Test Cable Wiring

2-10. Adjustment at Installation

TX/Sweep Timing Adjustment

If the following symptoms are observed on the radar screen, adjust sweep timing potentiometer VR101. See Fig.2-11.

* Straight quay or breakwater appears bent at the screen center on 1/2 n.m. range.
* Range error is found on short range.
* A Thick ring appears at screen center.


(a) Normal
(b) Straight target bent inward near screen center.
(c) Straight target bent outward and a ring appears near screen center.

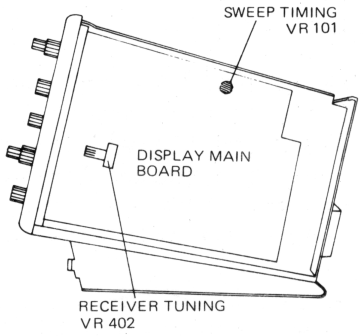


Fig.2-11 Sweep Timing Adjustment

Receiver Coarse Tuning

The best sensitivity should be given with the TUNING control at around its mid travel. If not, adjust tuning potentiometer VR402. See Fig.2-11.

1) Operate the radar for normal picture and leave it for about 10 minutes to stabilize the oscillation of magnetron.
2) Set the TUNING control at mid-travel. Adjust VR402 slowly so that a weak long range echo is discerned with maximum sensitivity.

Sweep Centering Adjustment

When the sweep origin deviates of the center the cursor, adjust it by turning the centering magnets. See Fig.2-12.

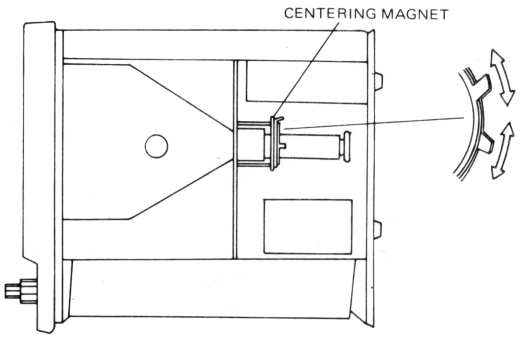


Fig.2-12 Centering of Picture

Heading Alignment

When the relative bearing of a target measured on the radar screen, "A" in Fig.2-13, does not agree with that measured on the navigation chart, "B", adjust reed switch S801 in the scanner unit. Move the reed switch in the same direction as the antenna rotation when "A" is greater than "B", and vice versa.

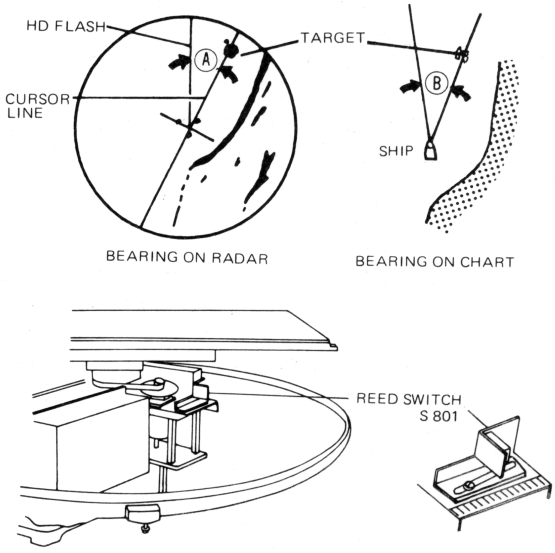


Fig.2-13 Heading Alignment

CHAPTER 3. MAINTENANCE

3-1. General

The radar system should maintain optimum performance for a reasonably long period of time. Factory adjustment or alignment of circuits does not require frequent readjustments and realignments. However, continued performance can not be expected without periodic inspection and maintenance.

Periodically, a thorough inspection of the equipment should be made. Cable connections at terminal boards and connectors should be kept clean and tight. Be sure all ground connections are secure and properly grounded. Arrange all wires and cables in orderly manner to prevent the possibility of arc-over or short. Replace all wires that show signs of corrosion, cracking or deterioration.

All units of the equipment should be kept clean and free from corrosion. Replace all missing knobs and defective or broken parts. Housing, shields, covers and other protective devices should be at their proper place and secured.

3-2. Cleaning and Lubrication

Cleaning lengthens the operating life of the equipment. Dirt on components can result in shortcircuits. A dry, soft cloth and soft bristled brush are recommended for removing loose dirt from the outside of the display and scanner units. Dirt on the inside of the units should be loosened with a soft-bristled brush and removed by using an electric cleaner.

Hardened dirt should be removed by using a mild detergent and water solution on a cotton-tipped swab or a soft cloth. Avoid excessive use of water. Do not allow water to penetrate any parts. Avoid the use of abrasives and chemical agents. Protect the display units from dirt and splash of sea water.

Corroded areas should be cleaned with a neutralizing solution of 2% borax and water to prevent further corrosion.

CAUTION:
After cleaning, the sets should be carefully inspected for defects such as poor connections, damaged parts and loosened mechanical parts.

Keep all moving parts properly lubricated using a cleaning-type lubricant on shaft bushings. Do not overlubricate.

Period	Item	Actions
Every month	Scanner Unit	Check for dirt or crack on the radome surface. Thick dirt should be wiped out by using soft cloth immersed with fresh water. If any crack is found, apply slight amount of sealing compound or adhesive. If necessary, replace it with new one.
	Plugs and jacks	Check that plugs and jacks are firmly fitted.
Every half a year	CRT screen and cursor plate	Clean up CRT surface and cursor plate as follows by using soft cloth with slight amount of anti-static-charge spray. Never apply plastic solvent. 1. Remove the display cursor panel, referring to page 3-9. 2. Clean up CRT surface and cursor plate with special care not to make scratch mark.
	Deflection coil mechanism	1. Clean up the slip ring p.c. board with soft dry cloth. 2. Check movement of deflection coil, and clean up gears if required. Note: Do NOT apply oil onto the coil turning gear.
Every year	CRT anode	High tension on CRT attracts dust in environment, and moist dust will cause poor insulation. Clean up high voltage parts as follows. 1. Turn off radar. 2. Pull out anode cap and touch its nipple to chassis (discharging). 3. Clean up anode cap/lead by using soft dry cloth. Note 1. If any crack is found on rubber cap or wire sheath, replace it with new one. 2. Never fail to put anode cap back to CRT after cleaning.

3-3. Removal and Replacement of Major Components in Scanner Unit

Refer to Dwg. Nos. C3248-008-A (SCANNER UNIT) and C3248-009-A (RF TRANSCEIVER ASSEMBLY/SCANNER DRIVING ASSEMBLY) on pages D-1 and D-2, respectively.

Radiator Assembly A-130A

1) Unfasten four fixing bolts A-147, and remove the radome upper assembly A-120A. See Fig.3-1.

2) Unfasten four M5x25 hex. bolts BT-104 by a wrench, and lift the radiator assembly A-130A up carefully. See Fig.3-2.

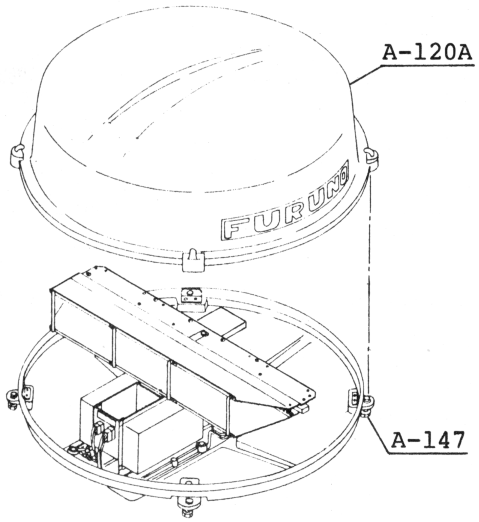


Fig.3-1

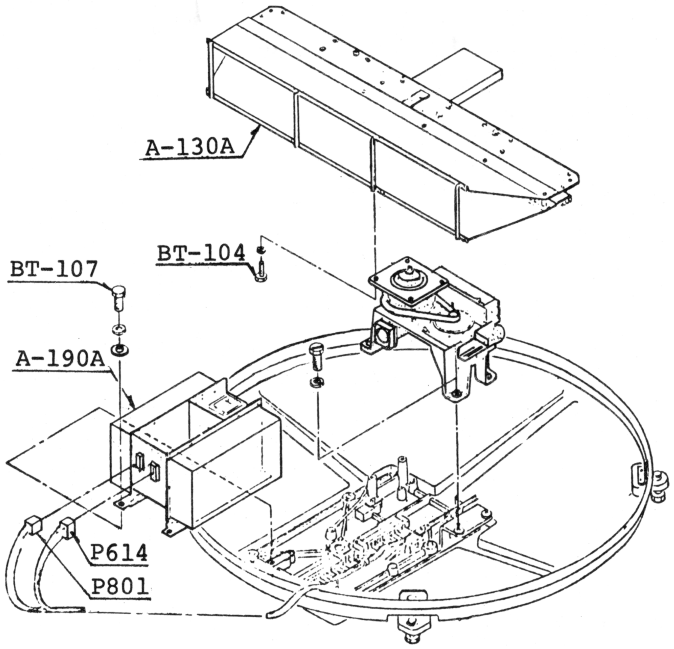


Fig.3-2

Timing Belt A-161

1) Remove the radiator assembly A-130A.

2) Loosen three M4x10 washer head screws S-106 and slide the motor fixing plate A-167 toward the idle pulley A-171, and tension of the timing belt is slacken. Take out the timing belt. See Fig.3-3..

NOTE: When refitting the timing belt, tension adjustment is required. Refer to page 2-9.

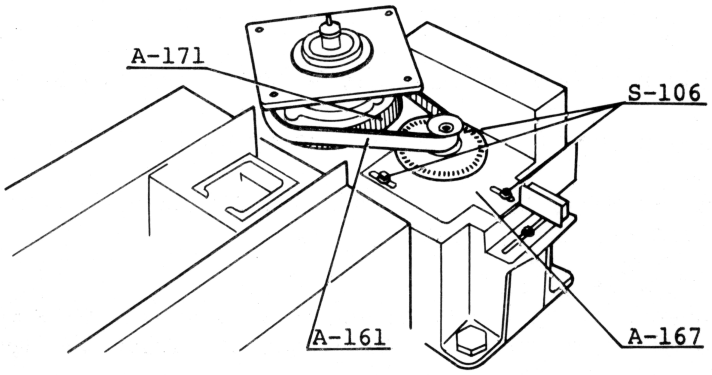


Fig.3-3

Scanner Motor B801

1) Remove the timing belt A-161. See Fig.3-3.

2) Remove the motor fixing plate A-167 with MC-4363 motor control p.c. board and the scanner motor. See Fig.3-3 above.

3) Unscrew two M4x5 setscrews S-115 and S-116, and the timing disk with drive gear A-168 comes out.

4) Disconnect the plug P931 on the motor control p.c. board.

5) Unscrew three M4x10 washer head screws S-113, and the scanner motor comes free.

NOTE: When replacing the motor, the motor mounting position on the motor fixing plate A-167 should be changed in accordance with the type of the motor.

*1 --- Type: 4322-010-78012
Code: 000-431-570
Applied to all MODEL 1600 radars.

*2 --- Type: OSR-F
Code: 000-432-000
Applied to radars produced Feb., 1981 and after.

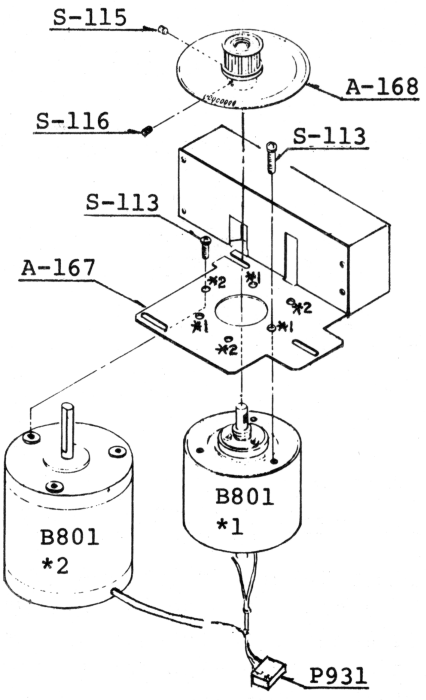


Fig.3-4

RF Transceiver Assembly A-190A

1) Remove the radome upper assembly A-120A. See Fig.3-1.

2) Disconnect plugs P614 and P801, referring to Fig.3-2.

3) Unfasten two M8x16 hex. bolts BT-107, and take out the RF transceiver assembly. See Fig.3-2.

NOTE: 1. When placing the RF transceiver assembly on steel desk, great care should be taken not to damage the magnetron mounted on the assembly.

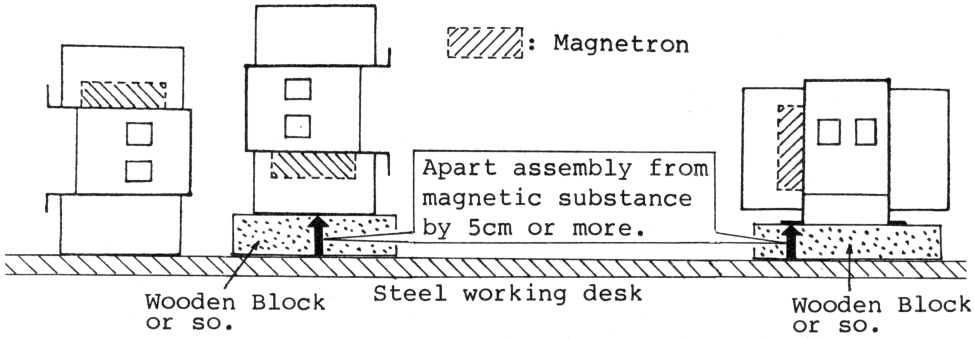

: Magnetron
Apart assembly from magnetic substance by 5cm or more.
Wooden Block or so.
Steel working desk
Wooden Block or so.

Fig.3-5

2. When putting the assembly back, take care that two guide pins are mated with the guide holes.

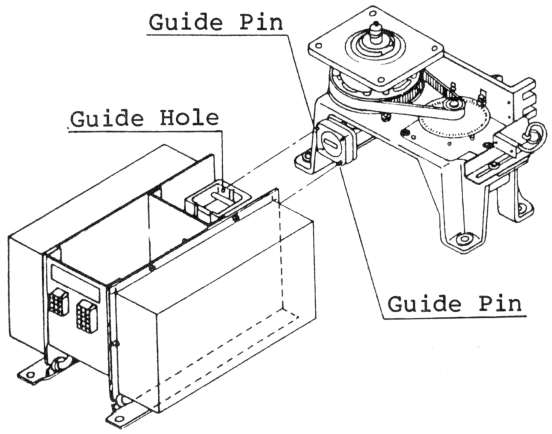


Fig.3-6

MD-4171, IF-4435 & MC-4363 P.C. Boards

MD-4171 modulator and IF-4435 IF amplifier p.c. boards are mounted on the RF transceiver assembly A-190A, whilst MC-4363 motor control p.c. board is mounted on the scanner driving assembly A-160A. These p.c. boards are covered with the shield cases A-191, A-192 and A-111, respectively. See Fig.3-7.

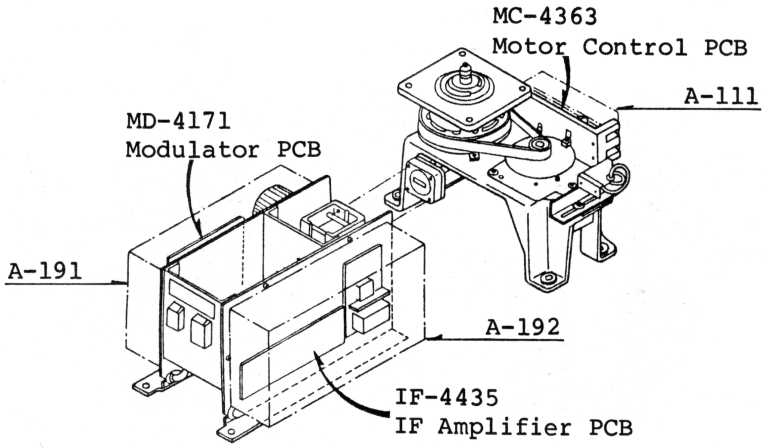


Fig.3-7

1) Unfasten four fixing bolts A-147, and remove radome upper assembly A-120A. See Fig.3-1.

2) Take out the RF transceiver assembly A-190A. See Fig.3-2.

3) Uncover respective shield cases A-191, A-192 and A-111, and these p.c. boards are in sight.

4) Disconnect plugs and loosen screws fixing each p.c. board.

Magnetron V801

NOTE: 1. Use a nonmagnetic screwdriver when replacing the magnetron.

2. Apart the magnetron from magnetic substance by 5cm or more. See Fig.3-5.

3. The magnetron must not be stored in the proximity of ferro-magnetic materials and stray magnetic field to prevent demagnetization.

4. As the magnetron has strong magnetic force, the watch should be taken off while replacing the magnetron to prevent the watch from getting damage.

1) Take out the RF transceiver assembly A-190A. See Fig.3-2.

2) Uncover the shield case cover A-191. See Fig.3-7.

3) Unsolder the magnetron heater lead wires from the pulse transformer T801. See Fig.3-8 on next page.

4) Loosen four M4x10 washer head screws S-124 with a nonmagnetic screwdriver, and carefully take out the magnetron.

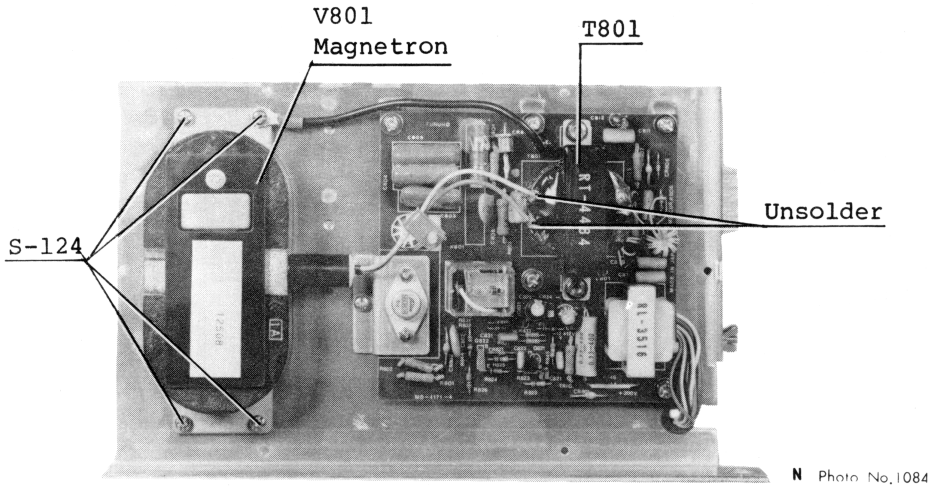


Fig.3-8

Circulator HY801 & MIC U801 w/Limiter CR810

1) Take out the RF transceiver assembly A-190A, referring to Fig.3-2. See Note 1 on page 3-5.

2) Uncover the shield case A-192. See Fig.3-7.

3) Disconnect the plug P612 connected to the IF-4435 p.c. board, and unscrew four M4x12 washer head screws S-119.

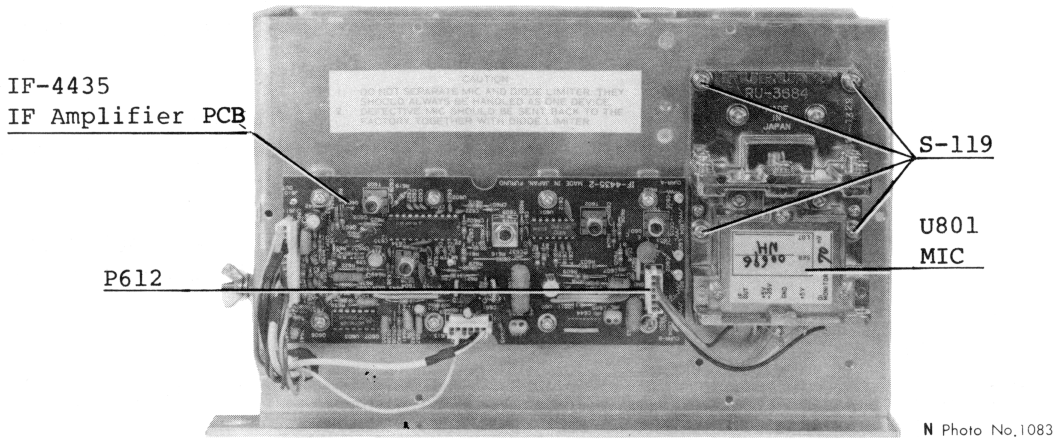


Fig.3-9

4) Carefully take out the assembly of MIC (w/limiter), circulator and adaptor *1*. Then, unscrew four M4x60 pan head screws S-111, and the MIC (w/limiter) and the circulator come free. See Fig.3-10.

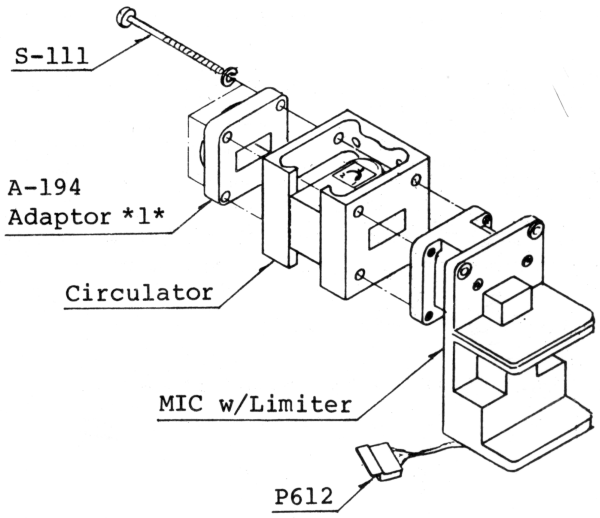


Fig.3-10

NOTE: 1. Do NOT separate the MIC and limiter. They should always be handled as one device.

2. The defective MIC should be sent back to the factory together with the limiter.

3. After installing a new MIC, never fail to remove the bare wire which shortcircuits across the lead pins on the MIC. Do NOT energize the radar before removing the shorting wire.

4. On replacement of the circulator, do NOT remove a piece of styrofoam inserted into a port of the circulator. As the magnet is used inside the circulator, metal filings are likely to be attached to it, and if these filings or dust come in, it causes poor sensitivity or deterioration of magnetron.

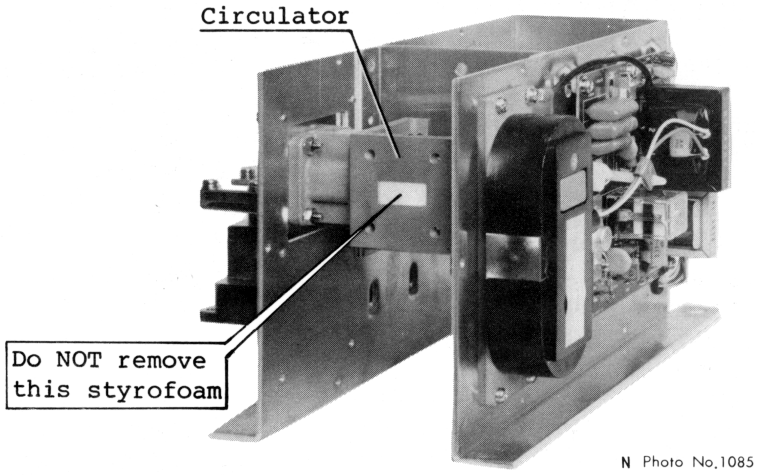


Fig.3-11

3-4. Removal and Replacement of Major Components in Display Unit

Refer to Dwg. Nos. C3248-010-A (DISPLAY UNIT) and C3248-011-A (DEFLECTION TABLE ASSEMBLY) on pages D-3 and D-4, respectively.

Cursor Panel A-217

1) Remove all control knobs except for the cursor knob by unscrewing M3x4 setscrews with a socket screw wrench.

2) Remove the display cover A-203.

3) Unscrew four M4x10 washer head screws S-215, and cursor panel A-217 comes free. See Fig.3-12.

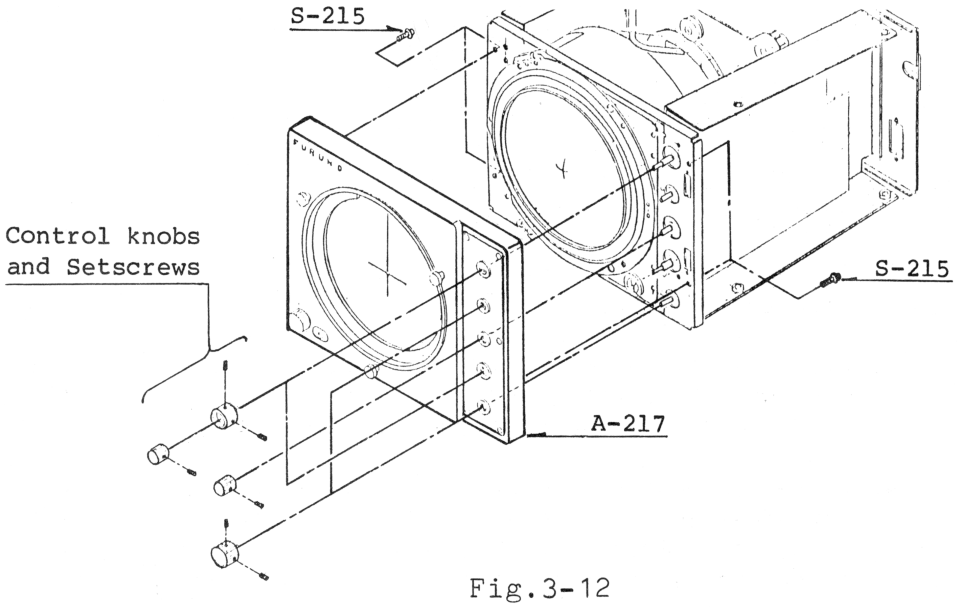


Fig.3-12

DU-4262 Display Main Board

1) Remove the cursor panel A-217.

2) Disconnect the connector plugs connected to the p.c. board.

3) Unscrew two M3x6 washer head screws S-214 on the front chassis and five M3x6 washer head screws S-209 on the p.c. board, and the DU-4262 p.c. board comes free.

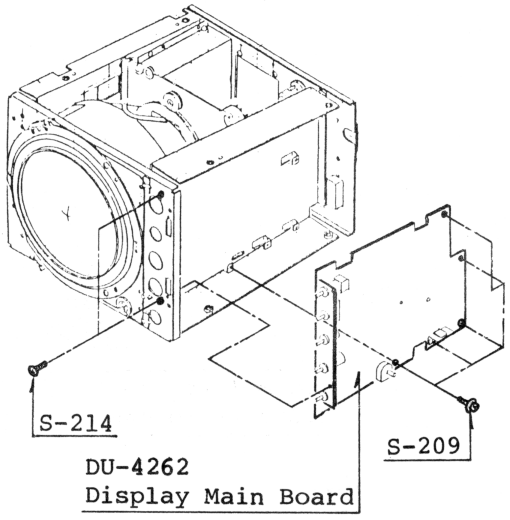


Fig.3-13

CRT V551

NOTE: Wait several minutes after switching off to discharge high tension.

1) Remove the cursor panel A-217.

2) Remove the blind plate A-242 by unscrewing four M3x6 washer head screws S-201, and pull out the CRT socket.

3) Unscrew M3x15 washer head screw S-212, and remove the CRT neck cover A-234.

4) Pull out the magnet mount A-237 with two centering magnets A-238/239 and spacer A-240.

   Note: The magnet mount is attached to the CRT neck by tape.

5) With great attention to the CRT high voltage, pull out the CRT anode cap. To discharge the high voltage remaining, ground the CRT anode and anode cap with a screwdriver of isolated handle.

6) Unscrew four M4x10 washer head screws S-225 on the front chassis, and the CRT with the CRT fixing plate assembly comes out.

7) Unfasten three M6 nuts N-201 and spring washers, and remove the CRT.

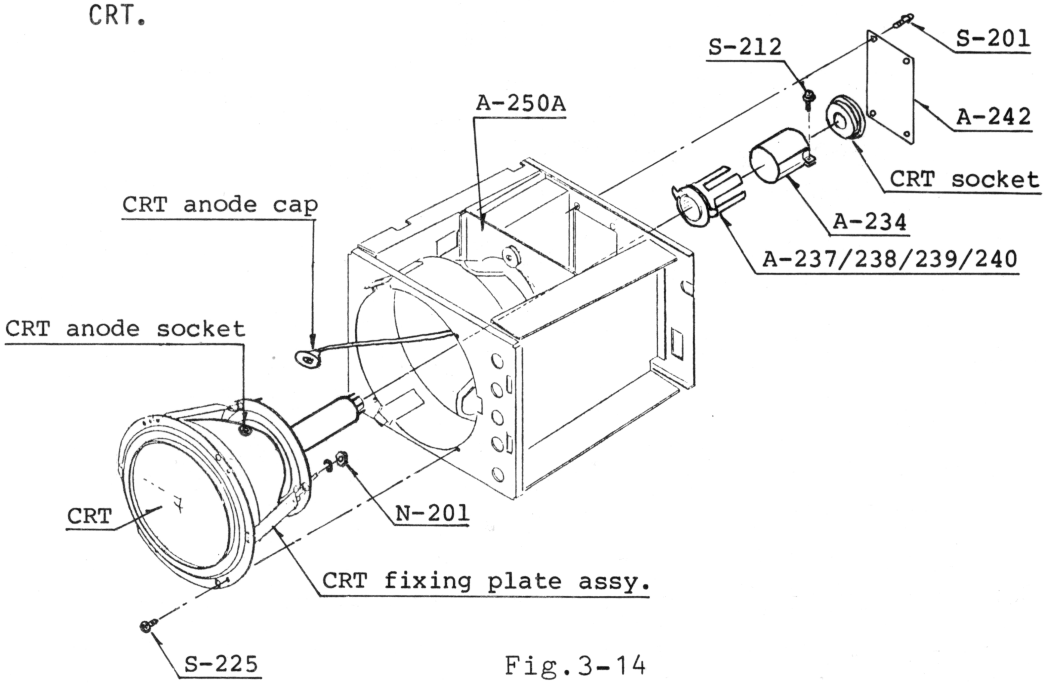


Fig.3-14

NOTE: When the CRT is replaced, the position of the deflection table assembly A-250A should be readjusted. Refer to the following.

Deflection Table Assembly A-250A

1) Remove the display cover A-203.

2) Remove the CRT, DU-4262 display main board and PT-4261 power supply p.c. board.

3) Unscrew four M4x10 washer head screws S-222, and the deflection table assembly A-250A comes out.

NOTE: When the CRT is replaced, the adjustment of the deflection table assembly position is required as follows. Move the deflection table assembly back and forth so that the assembly is placed in the nearest position to the CRT. Take care the assembly does not touch the CRT at any portion, then adjust the vertical position so that the CRT neck and the deflection coil are placed concentrically. If the deflection table assembly is placed backward excessively, the sweep trace is shortened or an abnor mal sweep may occur.

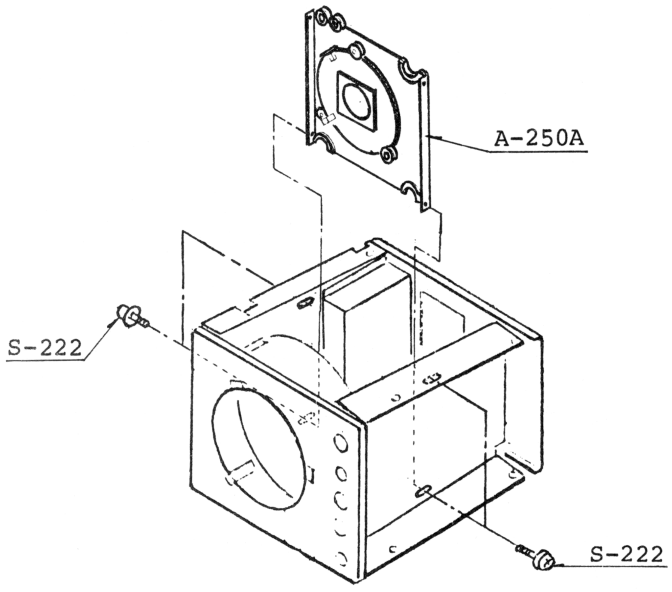


Fig.3-15

Deflection Coil L181 / SR-4466 Slip Ring P.C. Board

1) Remove the CRT.

2) Remove the bearing A-254 by unscrewing M4x20 hex. bolt BT-251, and take out the deflection coil together with the coil turning gear A-258 and the slip ring p.c. board.

3) Unfasten four M3x6 washer head screws S-256, and unsolder two deflection coil lead wires from SR-4466 slip ring p.c. board.

4) Separate the deflection coil from the coil turning gear A-258 by unscrewing four M3x8 washer head screws S-251.

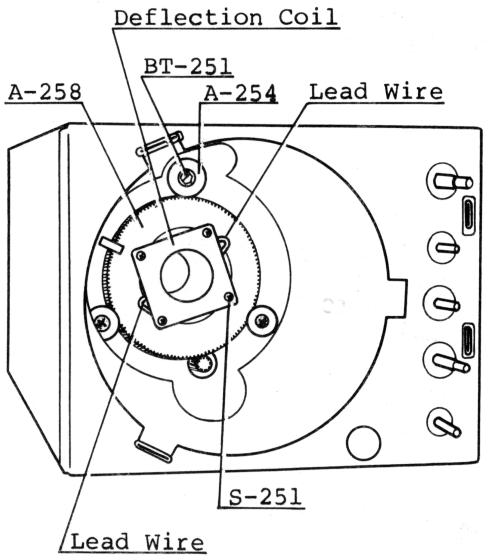


Fig.3-16

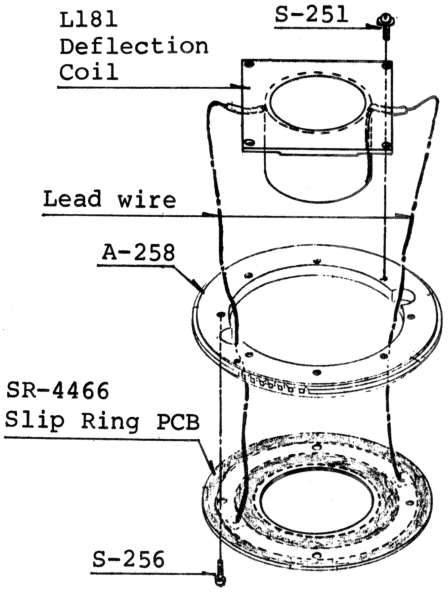
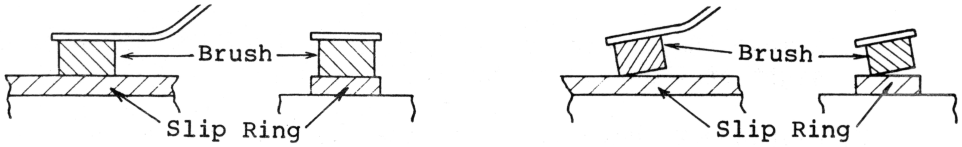


Fig.3-17

NOTE: 1. Do NOT lubricate the coil turning gear A-258. If the oil is put onto the gear, it spreads over the slip ring, where carbon powder from the brushes in mixture with the oil acts as abrasive and wears the slip ring.

2. When remounting the slip ring, adjust the contact between slip ring and brushes as shown below to prevent the slip ring from being quickly worn off by the brushes.



Good Contact

Bad Contact

Fig.3-18

Deflection Coil Drive Motor B1651

1) Take out the deflection table assembly A-250A.

2) Pull out the motor shield case *2* A-253, and unscrew two M3x10 washer head screws S-260. Take care not to lose nuts.

3) Remove the coil drive gear A-257 by loosening two M3x4 setscrews S-261.

4) Take out the motor from the motor shield case *3* A-252.

NOTE: Do not forget to put the motor shield cases on a new motor, otherwise the rugged range rings appears on the CRT due to magnetic field produced by the motor.

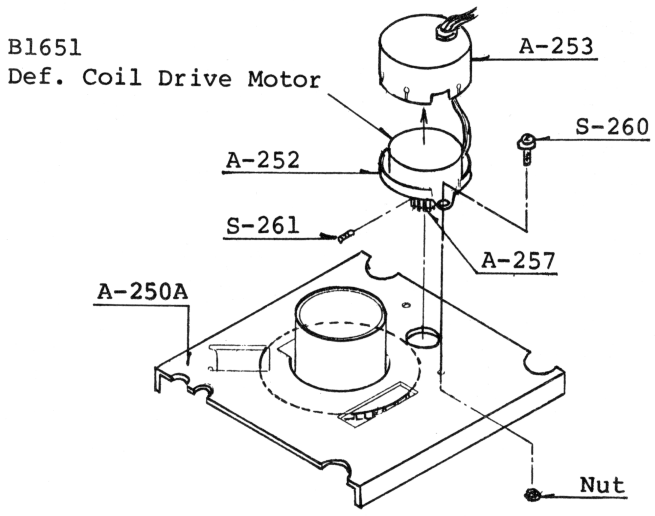


Fig.3-19

LP-4263, LP-4264 Lamp P.C. Boards

See Fig.3-20 on next page.

1) Remove the display cover A-203, and LP-4263 Lamp p.c. board is in sight at the rear of the front chassis.

2) Disconnect the plug P55 on the display main board.

3) Unscrew two M3x6 washer head screws S-216, and LP-4263 p.c. board comes out.

4) Remove the cursor panel A-217 referring to page 3-9, and two LP-4264 Lamp p.c. boards are in sight.

5) Disconnect the plug P56 on the display main board.

6) Unscrew M3x6 washer head screws S-218 and S-208, and LP-4264 p.c. boards come free.

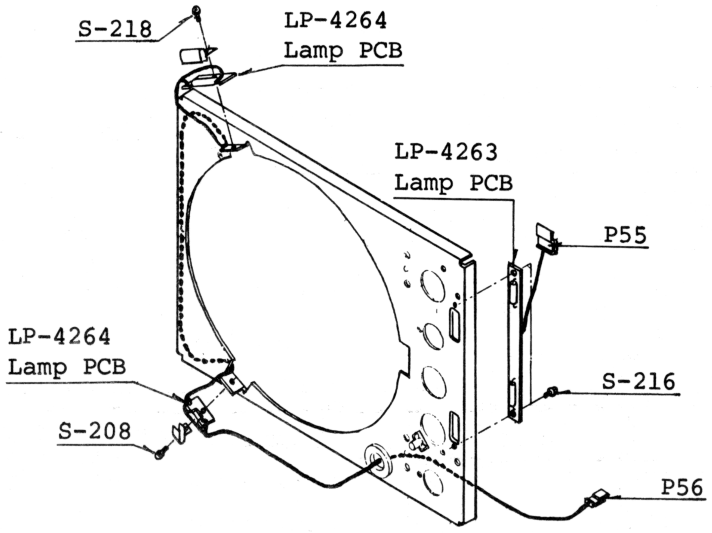


Fig.3-20

Contact Pin of Connector DP-1/DJ-1

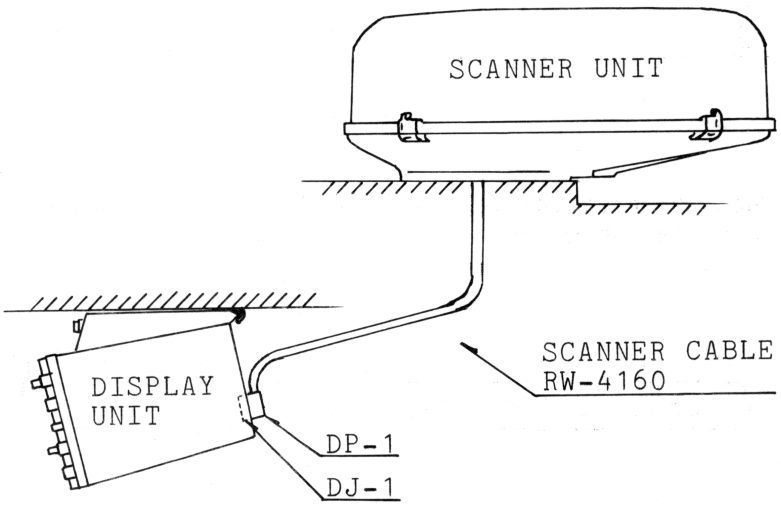


Fig.3-21

1) Open the connector plug DP-1.

2) Place the contact pin between the tips of the tool (MCP-KM), and push the tool until the contact pin with lead wire comes out.

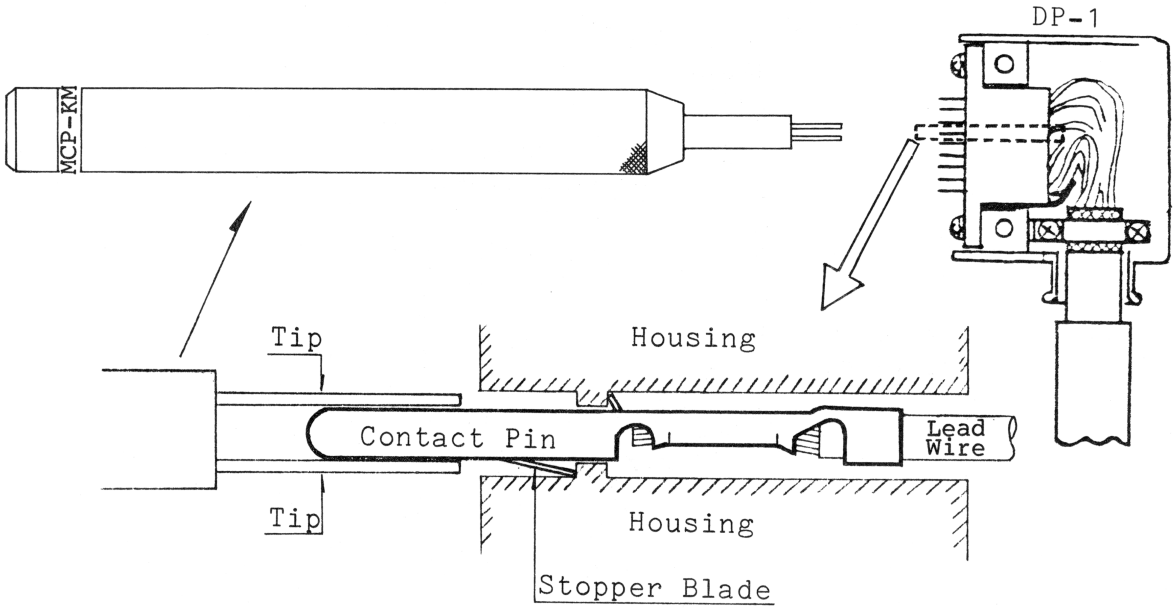


Fig.3-22

3) As for the jack DJ-1, do the same manner as above, but only the tool (MCP-KF) is different.

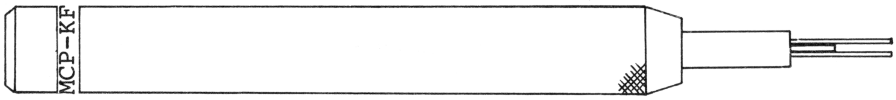


Fig.3-23

Note: When crimping the lead wire on the contact pin, crimp it at two points as shown below.

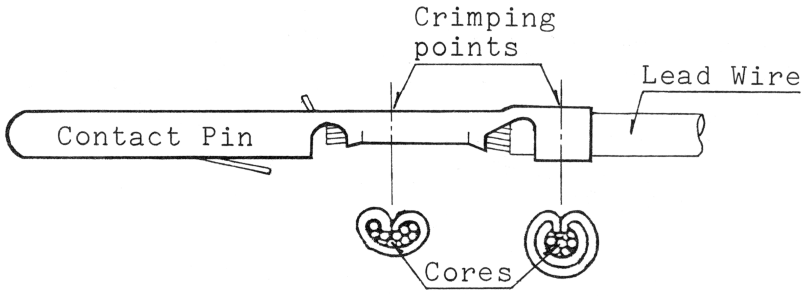


Fig.3-24

Special tools are

MCP-KM : for drawing out male contact pin of DP-1
MCP-KF : for drawing out female contact pin of DJ-1
KP-300A: for crimping contact pin of DP-1/DJ-1

Manufacturer: HONDA COMMUNICATION MFG. CO., LTD.

Contact Pin of Connector Plug P51, P52, P60, etc.

1) The lead wire is locked to the connector housing with a stopper blade on the contact pin. To remove the lead from the housing, press the stopper blade with a screwdriver as shown below and pull the lead out.

2) Before putting the lead to the plug, raise the stopper blade to 30° with a knife edge.

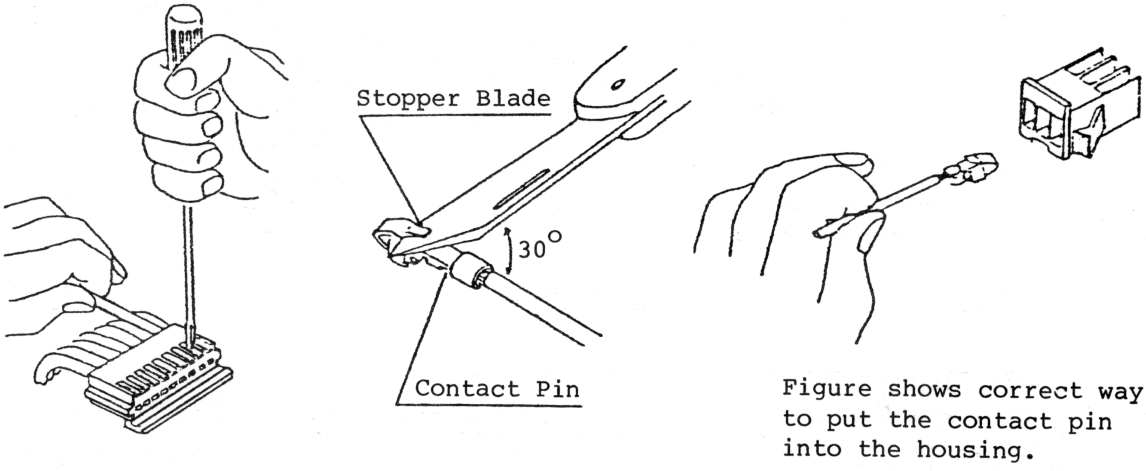


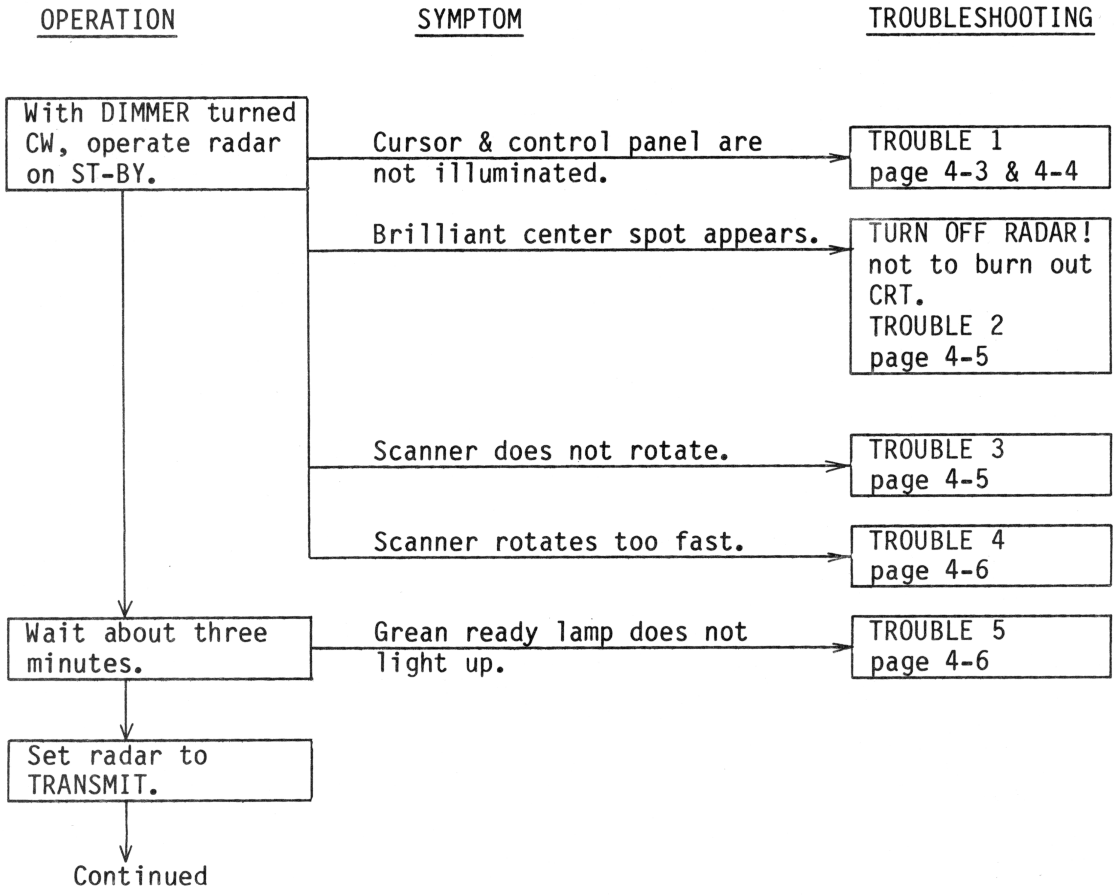
Fig.3-25

CHAPTER 4. TROUBLESHOOTING

4-1. Trouble Tracing Chart

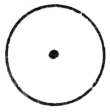
To facilitate the procedure for trouble tracing, the following flow-chart is arranged. After trouble is traced down to a certain "trouble", proceed to the "4-2. Troubleshooting" for further information.

Initial Checks:	CONTROLS	POSITIONS
1) Place the front panel controls and switches as shown right.	FUNCTION	OFF
	RANGE	16 n.m.
2) Check the input voltage and polarity between J1351 #1 (+) and #2 (-).	TUNING	Mid-travel
	OTHERS	Fully CCW


OPERATION
SYMPTOM
TROUBLESHOOTING
With DIMMER turned CW, operate radar on ST-BY.
Cursor & control panel are not illuminated.
TROUBLE 1 page 4-3 & 4-4
Brilliant center spot appears.
TURN OFF RADAR! not to burn out CRT.
TROUBLE 2 page 4-5
Scanner does not rotate.
TROUBLE 3 page 4-5
Scanner rotates too fast.
TROUBLE 4 page 4-6
Wait about three minutes.
Grean ready lamp does not light up.
TROUBLE 5 page 4-6
Set radar to TRANSMIT.
Continued

With BRILLIANCE turned CW, rotate RANGE switch.

Sweep trace is absent on all ranges. → TROUBLE 6 page 4-7



Only center spot on all ranges. → TROUBLE 7 page 4-8

Only center spot on specific ranges. → TROUBLE 8 page 4-9

Fly-back trace appears. → TROUBLE 9 page 4-9

Sweep trace does not rotate. → TROUBLE 10 page 4-9

Heading flash does not appear. → TROUBLE 11 page 4-11

Heading flash is not settled. → TROUBLE 12 page 4-11

Press HD-FL OFF button momentarily, then release it.

Heading flash is not reset to screen top does not appear at zero degs of bearing scale. → TROUBLE 13 page 4-11

With BRIL/RING control pulled, rotate RANGE switch.

Range rings do not appear on all ranges. → TROUBLE 14 page 4-12

Abnormal ring interval on all ranges. → TROUBLE 15 page 4-12

Range rings disappear in specific direction. → TROUBLE 16 page 4-12

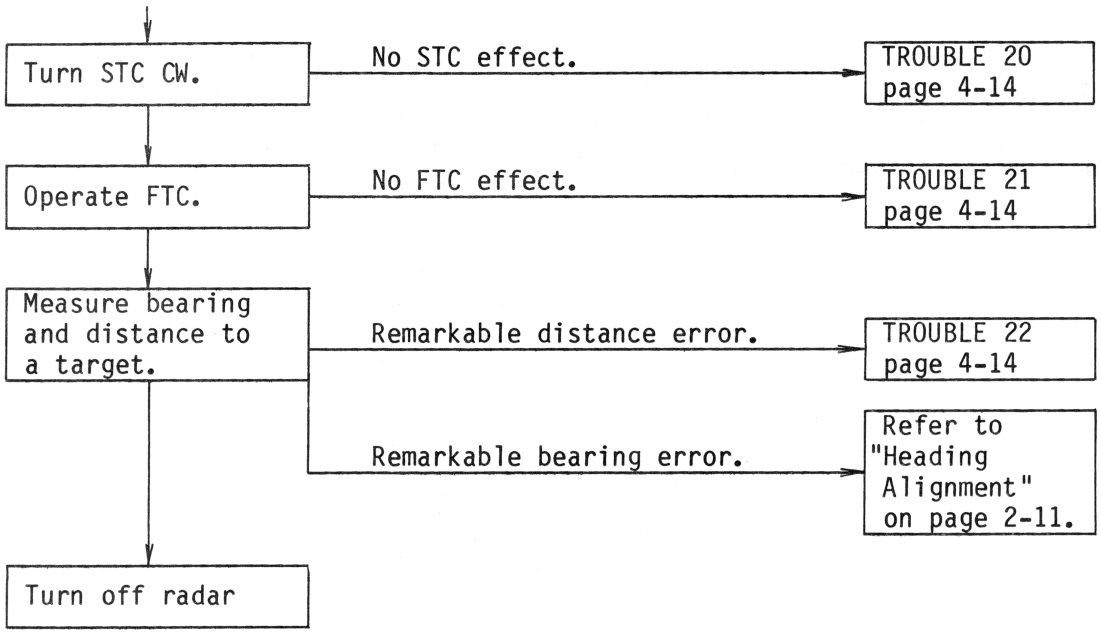
With GAIN at 70%, adjust TUNING for max. detection.

No echo nor noise appears. → TROUBLE 17 page 4-13

Noise appears but no echo. → TROUBLE 18 page 4-13

Best tuning is not obtained at mid-travel of TUNING control. → TROUBLE 19 page 4-14

Continued



4-2. Troubleshooting

Trouble 1. Cursor and front panel are not illuminated.

Cause:
* Main fuse F1351 blown off.
* Illumination lamps DS51 thru DS54 and associated circuit defective.
* Shortcircuit on DC line.
* Power Transistor Q1304 & Q1305 shorted.
* Power Transformer T1 cut off or shorted.
* 25kHz PWM inverter faulty.
* 25kHz inverter faulty.

Check/Remedy:

1) Check if fuse F1351 is blown off. If it is blown off, replace it with new one 10A. Then, operate the radar and check the fuse again. If new fuse is blown off again, inverter output transistors (Q1304 and Q1305), 9V regulator (Q1301) or power transformer (T1) are defective. (Note: Incorrect polarity of power supply also blows off the fuse F1351.)

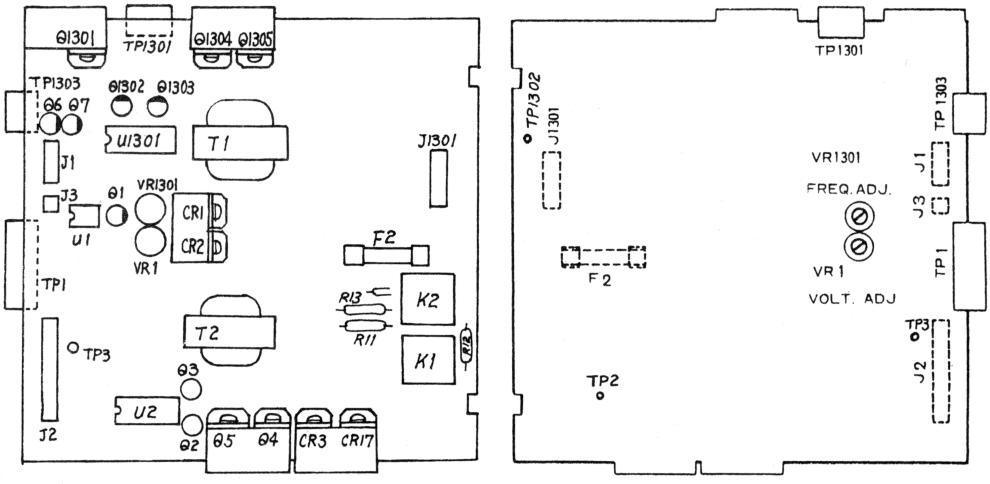
2) Measure the DC voltage between TP-1 #10 (+) and #9 (-) on p.c.b. PT-4261 by DC30V voltmeter. See Fig.4-1. If the meter reads approx. 7.3V, the inverter and rectifier circuits are operating normally. Check the illumination lamps DS51 thru DS54 and the associated circuit (VR51, P1, P51, P54, P55 & P56).

3) If fuse F1351 is alive, it is considered that the protector circuit is operating. Remove three connector P1, P2, P3 and connect a jumper wire between pin #1 and #2 of J1. Then, check the DC voltage between TP1 #7 (+) and #4 (-) by DC30V voltmeter. See Fig.4-1. If the meter reads approx. 11.8V, this trouble is caused by shortcircuit on DC lines.

4) If the protector circuit still operates in above condition, disconnect the jumper wire and remove fuse F2 (5A). Then, connect again the jumper wire in order to restart the inverter. If the meter reads approx. 11.8V, 25kHz inverter circuit is defective. Check Q4, Q5, CR10 to CR17 and T2.

5) If the protector circuit functions again with F2 removed, 25kHz P.W.M. Inverter circuit is faulty. Check Q1301 thru Q1305, Q1, U1301 and CR1 thru CR5.

Voltage Check Points	Ratings
TP1301 #6 (+) & #2 (-)	10.2V to 40V
TP1301 #1 (+) & #2 (-)	8V to 9V
TP1 #1 (-) & #4 (+)	-187V to -255V
TP1 #3 (-) & #4 (+)	-11.4V to -12.6V
TP1 #5 (+) & #4 (-)	4.75V to 5.25V
TP1 #6 (+) & #4 (-)	11.68V to 11.92V
TP1 #7 (+) & #4 (-)	11.68V to 11.92V
TP1 #8 (+) & #4 (-)	30V to 35V
TP1 #10(+) & #9 (-)	6.84V to 7.56V
TP1 #11(+) & #4 (-)	66.8V to 73.5V (1/2M) 23.7V to 26.3V (2M) 9.5V to 10.5V (16M)
TP1 #12(+) & #4 (-)	69.3V to 76.7V
TP3 (+) & TP1 #4 (-)	287V to 317V



a) Component Side b) Wiring Side

Fig.4-1 Power Supply Circuit of Display Unit

Trouble 2. Brilliant center spot appears in ST-BY.

Cause:
* Faulty CRT.
* Defective -220V line on p.c.b. DU-4262.
* Defective -100V regulator (CR502 thru CR504) on p.c.b. DU-4262.

Check/Remedy:

1) TURN OFF RADAR! in order not to burn out CRT. Then, remove P501, P502, P503 from the p.c.b. DU-4262. See Fig.4-2.

2) Restart the radar and check the grid-cathode bias voltage of CRT by connection a DC voltmeter between J503 #4 (neg) and chassis (pos). Normally it is greater than 100V d.c. If the bias voltage is alive there, CRT is defective.

3) If no or very low bias voltage is measured, check -220V line at J52 #1 and -100V regulator diodes CR502 thru CR504 shown in Fig.4-2.

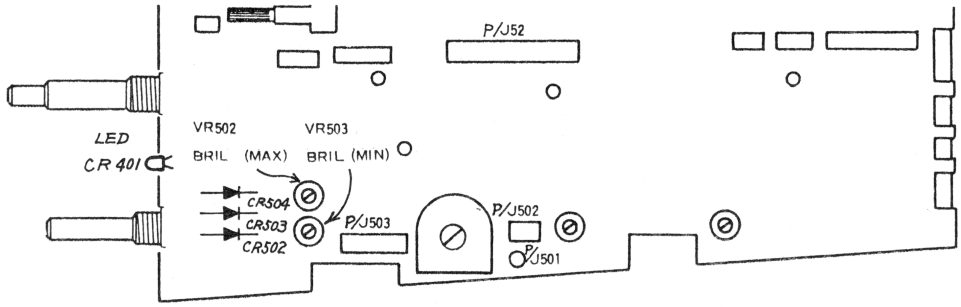


Fig.4-2 Brilliance Circuit on Display Main P.C.B. DU4262

Trouble 3. Scanner does not rotate.

Cause:
* Fuse F1352 blown off.
* Defective scanner rotating mechanism (Bearing A-162/163 jammed or Timing belt A-161 cut off. Refer to Dwg. No. C3248-009-A on page D-2.)
* Scanner motor B801 faulty.
* Poor connection between scanner and display unit.
* Motor Control p.c.b. MC-4363 defective.

Check/Remedy:

1) Check whether fuse F1352 is blown off. If it is blown off, replace it with new one (1A). Then, check if the fuse is blown off again.

2) If the fuse is blown off again, the scanner rotating mechanism is jammed or the scanner motor is shorted. Rotate the antenna radiator by hand. If the radiator does not rotate smoothly, remove the radiator assembly from scanner driving assembly. Then, replace the defective bearing (A-162/163) with new one. If the radiator rotates smoothly, the scanner motor or motor control circuit MC-4363 is shorted.

3) Check if the timing belt for scanner driving assembly is cut off. If it is cut off, replace it with new one and adjust the tension referring to section 2-9 of chapter 2.

4) Check the DC voltage between #3(+) and #1(-) of J931 (Scanner Motor Voltage) on motor control p.c.b. MC-4363. See Fig-4-3. Normal reading is approx. 2.2V. If no voltage is applied, p.c.b. MC-4363 is faulty.

5) If approx 14V is measured, the scanner motor is defective (open circuit).

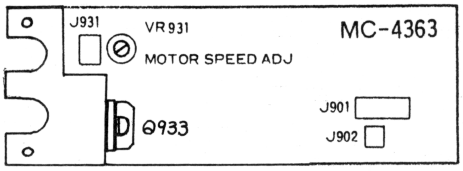


Fig.4-3 Motor Control p.c.b.

Trouble 4. Scanner rotates too fast.

Cause: * Motor Control p.c.b. MC-4363 defective.

Check/Remedy 1) Check the voltage between J931 #3(+) and #1(-). If it is nearly 24V, Q933 is shorted. See Fig.4-3.

2) If the voltage is about 14V, other components or motor control p.c.b. are defective.

Trouble 5. Green ready lamp does not light up.

Cause:
* Fuse F2 (5A) blown off.
* +5V line is off.
* Faulty timer circuit U111.
* Defetive green ready lamp (LED) CR401.

Check/Remedy: 1) Check if fuse F2 (5A) on power supply p.c.b. PT-4261 is blown off. If it is blown off, replace it with new one. See Fig.4-1.

2) Check that +5V is applied between P52 #8(+) and #6(-) on the p.c.b. DU-4262. If not, check the continuity between J2 on p.c.b. PT-4261 and J52 by ohmmeter.

3) Check that the lamp drive voltage (+4V to +5V) is applied between U111 pin #8 (+) and GND (-) on p.c.b. DU-4262. If the drive voltage is applied, the LED CR401 or its associated circuit is defective. See Fig.4-4.

4) If the voltage at U111 pin #8 stays at 0V, Timer IC U111 is faulty. See Fig.4-4.

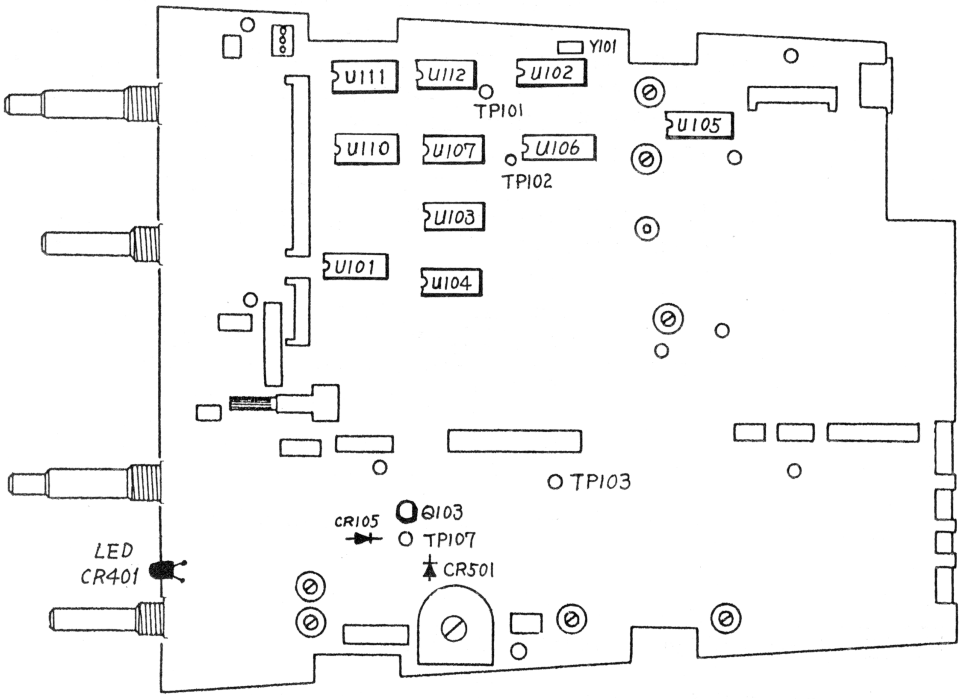


Fig.4-4 Timebase & Unblanking Circuit on Display Main p.c.b. DU-4262

Trouble 6. Sweep trace is absent on all ranges.

Cause:
* CRT heater cut off.
* Faulty CRT High Voltage Supply.
* Faulty Timebase circuit (U101 thru U104 & Y101)
* Faulty Sweep Timing circuit (U106)
* Faulty Sweep Duration circuit (U105, U107, U110, U112)
* Faulty Unblanking circuit (Q103, CR105)
* +75V line cut off

Check/Remedy

1) Check the voltage at TP101 on the display main p.c.b. See Fig.4-4. Normal reading is approx 2V d.c. If it is either 0V or 5V, Reference Oscillator (Y101 and U102) is defective.

2) Check the voltage at TP102. Normal reading is about 2V d.c. If it is 0V or 5V, Timebase (U101, U103 & U104) is defective.

3) Check the voltage at TP103. Normal reading in short ranges is 0.7V approx. If it is 0V or 5V, Sweep Timing circuit (U106) or Sweep Duration circuit (U105, U107, U110 & U112) is faulty.

4) Turn the FUNCTION switch between TRANSMIT and ST-BY, measure the voltage at TP107. Normal reading is approx. -130V d.c. If the voltage changes in different settings of FUNCTION switch, the unblanking circuit is working normally. Check if CR501 is shorted. Then, check visually the CRT heater is lit. Check also the CRT anode voltage by the following method.

   * Switch off the radar and pull out the CRT anode cap with special care, then approach it to chassis. If normal, a sparking occurs at 5 to 10 mm separation.

5) If the voltage at TP107 does not change in different settings of FUNCTION switch, check the voltage at Q103 emitter. Normal reading is approx. 3V in TRANSMIT and 0V in ST-BY. If it is approx. 55V, Q103 is shorted.

Trouble 7. Only Center Spot on all ranges

Cause:
* Defective deflection coil.
* Faulty deflection transistor Q106.
* Defective deflection power supply.
* Faulty sweep circuit, U115, U116, U117, Q104 Q105, Q108.
* Faulty +12V or -12V line.

Check/Remedy:

1) In different settings of the RANGE switch, check the voltage at J53 #1. (Deflection Power Supply). See Fig.4-5. Normal reading is

   66.8V to 73.5V (1/2M)
   23.7V to 26.3V (2M)
   9.5V to 10.5V (16M)

2) Ensure the line voltages of +12V and -12V are applied at J52 #9 (+12V) and #3 (-12V) respectively.

3) Measure the voltage at J151 #4. If no voltage is applied, check the continuity of the deflection coil and brushes. Then, check if Q106 is shorted.

4) Check the voltage or waveform at pin #6 of U116. Normal voltage is approx. -0.2V. The waveform is shown in the schematic diagram. If it is not in order, sweep circuit U115, U116 or Q104 is faulty.

5) Check the voltage or waveform at pin #6 of U117. Normal voltage is about 0.3V. If it is not in order, U117 or Q108 is defective.

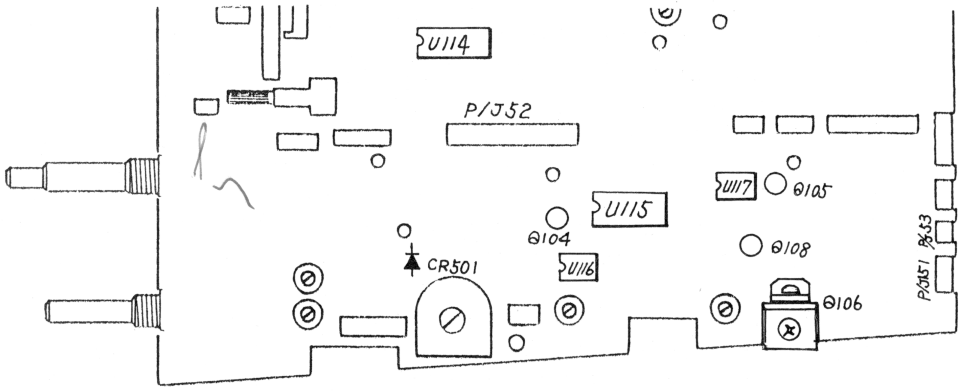


Fig.4-5 Sweep Circuit on Display Main P.C.B. DU4262

Trouble 8. Only Center Spot on specific range(s).

Cause: * Faulty Deflection Power Supply Circuit
* Relays K1/K2 and associated circuit are defective.

Check/Remedy 1) Changing the range, check if relays K1 and K2 operate as below. See Fig.4-1.

1/2 and 1 n.m. ranges: K1 OFF, K2 ON
2 thru 8 n.m. ranges : K1 ON, K2 OFF
16 n.m. range : K1 OFF, K2 OFF

2) If the relay does not operate, relay itself or its drive circuit Q6, Q7 or U114 is defective.

3) If the relay operates normally, check if resistor R11, R12 or R13 is cut off.

Trouble 9. Fly-back trace appears.

Cause: * Defective diode CR501 on p.c.b. DU-4262.

Check/Remedy: 1) Switch off the radar. Then check the diode CR501 with multimeter set to ohm range. See Fig.4-1.

Trouble 10. Sweep trace does not rotate.

Cause: * Defective deflection coil drive motor B1651.
* Faulty auto-heading align circuit on p.c.b. DU-4262.
* Defective heading flash key S801.
* Faulty bearing signal generator on p.c.b. DU-4262.
* Poor connection betweeb scanner and disply.

Check/Remedy: 1) Check if the drive voltage is applied to the deflection motor B1651. Measure the voltage between chassis (-) and pins #3, #4, #5 and #6 of J1651 (+) on p.c.b. DU-4262 with a multimeter set at AC30V range. If the meter reads 10V to 15V in all pins, the auto-heading align circuit is good. Check deflection motor B1651.

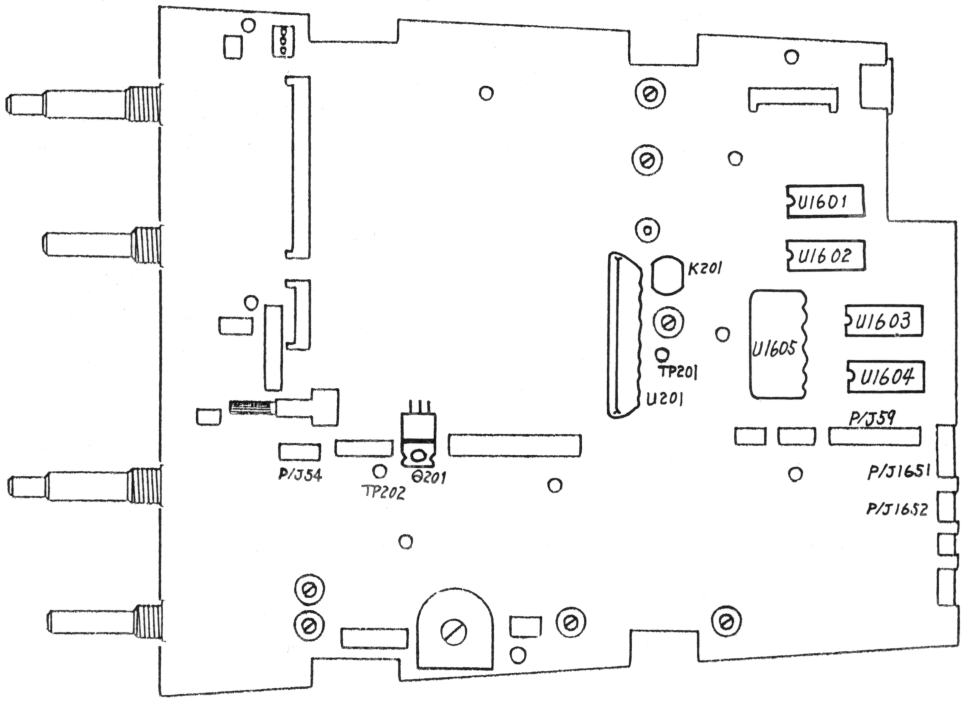


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Fig.4-6 Auto-Heading Alignment Circuit on p.c.b. DU4262

2) If the drive voltage is not applied, check if the bearing and heading signals are applied from the scanner unit to the display unit.

   For the heading flash checking, connect the multimeter set at DC30V between #8(+) and #9(-) of P/J59. In normal operation, the meter swings from +12V to +1V when the heading flash key S801 in closed. If the meter indication stays at 12V d.c., heading flash key S801 in the scanner unit is defective or the connection between the heading flash key and the display unit is cut off.

3) For the bearing signal checking, connect the multimeter, set at AC30V, between P/J59 #7 and #9. In normal operation, the meter reads about 11V a.c. If not, the bearing signal generator or photo interrupter U901 on Motor Control p.c.b. MC-4363 in the scanner unit is defective or the connection between scanner and display units is off.

4) If both the heading flash and bearing signal are normal, the auto-heading align circuit (U1601 thru U1605) is defective.

Trouble 11. Heading flash does not appear.

Cause: * Faulty Video Amplifier on p.c.b. DU-4262.
* HD-FL OFF switch defective.

Check/Remedy: 1) With the RANGE RING switch turned on, confirm that range rings are displayed. If not, the video amplifier (U201 & Q201) is defective.

2) Check +12V heading flash power supply between #4(+) and #3(-) of P/J54 on p.c.b. DU-4262 with a multimeter set at DC30V range. If not, replace the HD-FL OFF switch.

Trouble 12. Heading flash is not settled.

Cause: * Slotted disk for bearing signal (in the scanner unit) is defective or masked by dust.
* Scanner driving assembly defective.
* Deflection coil drive gear assembly defective.

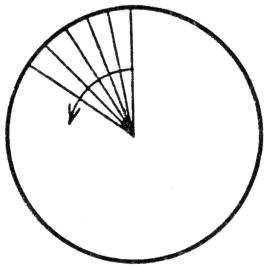


Fig.4-7

Check/Remedy: 1) Check visually the slotted disk holes.

2) Check whether the teeth of the scanner driving pulley and timing belt are worn off.

3) Check the deflection coil drive gears.

Trouble 13. Heading Flash is not reset to screen top. (Heading Align Reset)

When the HD-FL OFF switch is depressed (HD-FL OFF/HEADING ALIGN RESET), the sweep trace should stop at screen top once, then, start rotation when the antenna radiator faces dead ahead.

Cause: * Faulty photo-interrupter U1651.
* Defective IC (U1601 & U1602) on p.c.b. DU-4262.

Check/Remedy: 1) If the sweep trace does not stop at screen top, check the function of photo-interrupter U1651. Connect a multimeter set at DC30V range between P/J1652 #2(+) and #3(-). See Fig.4-6.

2) If the meter reading drops from 12V to 0V at the interval of one rotation of deflection coil, the photo-interrupter is normally operating. Check ICs U1601 and U1602.

Trouble 14. Range rings do not appear on all ranges.

Cause: *Faulty Video Amplifier (U201 and Q201).
*Faulty Range Ring circuit (U106 and U108).

Check/Remedy 1) If heading flash is also absent, check transistor Q201 and IC U201 on p.c.b. DU-4262. See Fig.4-6.

2) If heading flash appears, check ICs U106 and U108. See Fig.4-4.

Trouble 15. Abnormal ring interval on all ranges.

Cause: * CRT anode voltage varied.
* Faulty Sweep circuit.

Check/Remedy: 1) If abnormal number of range rings (with same interval each other) appear on all ranges as shown in Fig.4-8(a), check the CRT high voltage is within 7.5kV to 8.5kV.

2) If the CRT high voltage is within ratings, adjust the sweep velocity potentiometer VR102 referring to chapter 2.

3) If the range ring intervals differ as the distance increases on all ranges as shown in Fig.4-8(b), the sweep circuit is faulty.

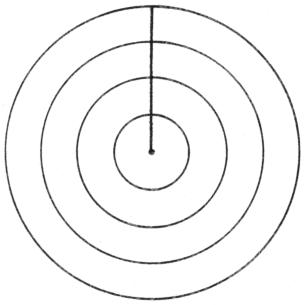


Fig.4-8(a)

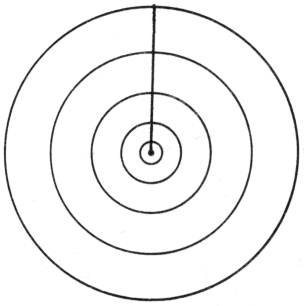


Fig.4-8(b)

Trouble 16. Range rings disappear in specific direction.

Cause: * Poor contact between slip ring and brush.

Check/Remedy 1) Clean the slip ring.

2) If the slip ring is scrached deeply by the brush, replace both the slip ring and brushes and adjust the brush contact referring to chapter 3.

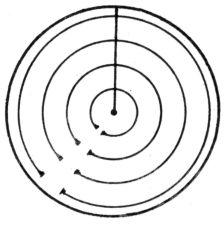


Fig. 4-9

Trouble 17. No echo nor noise appears.

Cause:
* Defective Video Amplifier
* Discontinuity or shortcircuit of coaxial cable.
* Faulty IF Amplifier.

Check/Remedy:

1) Remove video input plug P201. Then, connect the multimeter, set at DC3V range, between center pin (-) and outer shield (+) of plug P201.

2) With the STC turned fully CCW, turn the GAIN between extremes. If the meter reading varies with respect to the setting of the GAIN, IF amplifier and coaxial cable are O.K. Check the Video amplifier on p.c.b. DU-4262.

3) If the meter reading does not vary, check the continuity of the coaxial cable between the display and scanner units.

4) Then check the IF amplifier

Trouble 18. Noise appears but no echo.

Cause:
* Fuse F1 (0.5A) blown off.
* Modulator SCR shorted.
* Defective Trigger Generator circuit
* Modulator Trigger circuit faulty.
* Magnetron heater voltage not applied.
* Magnetron defective.
* Faulty IF Amplifier

Check/Remedy:

1) Check fuse F1 (0.5A) is blown off. If it is blown off, replace it. Then, restart radar in stand-by. If the fuse is blown off again, SCR CR803 or pulse forming network is shorted. Check them with multimeter in ohm range.

2) If fuse F1 is not blown off, check the magnetron current by measuring the voltage at P801 #3 on the RF transceiver assembly. Normal reading is within 1.8V to 2.4V d.c.

3) With the FUNCTION switch set at ST-BY, check the magnetron heater voltage between P801 #7(+) and #11(-) on the RF transceiver assembly. In normal operation, the magnetron heater voltage is within 6.5V to 7.0V .

4) Check the voltage and waveform at TP106 on p.c.b. DU-4262. Normal voltage reading is approx. 3V on 1/2 n.m. range.

*If the voltage at TP106 is fixed at 0V, Q102 is shorted.
*If it stays at 12V, U109, U107 or U101 is defective.

5) If the magnetron current is normal, check the voltage at P/J614 #9 "D.C. MONITOR" in on the RF transceiver assembly. It should be within ± 20% of the voltage indicated on Mixer U801. If it is within the rating, the IF Amplifier is defective. Replace whole the IF Amplifier assembly.

Trouble 19. Best tuning is not obtained at mid-travel of TUNING control.

Cause: * Frequency deviation of Magnetron.

Check/Remedy: 1) Adjust tuning preset VR402 on p.c.b. DU-4262, referring to "Adjustment at Installation" on page 2-11.

NOTE: ALLOW ABOUT 20 TO 30 MINUTES AFTER SWITCHING ON THE RADAR FOR WARMING UP THE MAGNETRON.

Trouble 20. No STC effect.

Cause: * STC circuit faulty.

Check/Remedy: 1) Check the STC waveform at TP602 on the IF Amplifier p.c.b. in the scanner unit.

2) Check the trigger waveform between P/J611 #4 and #3. Normal waveforms are shown in the schematic diagram.

Trouble 21. No FTC effect.

Cause; * Faulty FTC circuit in the Video Amplifier.

Check/Remedy: 1) Check the FTC circuit in the first stage of the Video Amplifier.

Trouble 22. Remarkable distance error on all ranges.

Cause: * Frequency deviation of Reference Oscillator Y101.

Check/Remedy: 1) Replace crystal Y101.

CHAPTER 5. TECHNICAL DATA

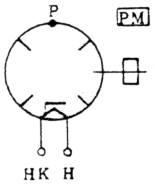
The waveforms and voltages on principal points are shown on the circuit diagram.

5-1. Characteristics of Major Electrical Components

Parts Name	Page
Magnetron	5-2
Circulator	5-3
Limiter	5-4
Cathode Ray Tube	5-5
CRT High Voltage Power Supply	5-6
Crystal	5-7
Diodes	5-8
Zener Diodes	5-8
Transistors	5-10
Light Emitting Diode	5-12
Voltage Reference Diode	5-12
SCR	5-13
Thermistor	5-13
Digital Integrated Circuits	5-14 & 5-15
Linear Integrated Circuits	5-16 thru 5-19

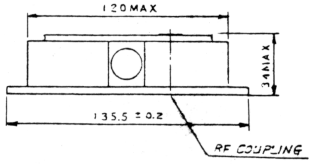
SPECIFICATIONS OF MAGNETRON

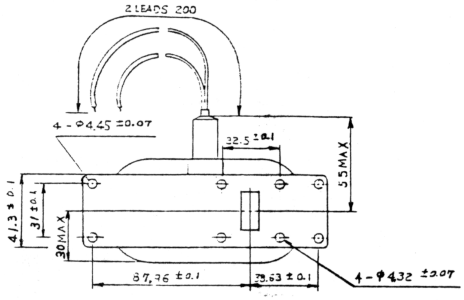
Type	9M302/E3513
Furuno Code No.	000-101-730
Applications	9410MHz band radar pulse transmission
Substitute	9M302, M599F, JP9-2.5



Maximum Ratings

	Min.	Max.	Unit
Heater Voltage (Ef)	5.7	6.9	V
Cathode pre-heating time (tk)	120		sec.
Peak anode voltage (eb)	3.2	3.8	KV
Rate of rise of voltage pulse (rrv)		60	KV/us
Peak anode current (ib)	2.5	3.5	A
Average anode current (Ib)		3.5	mAdc
Peak input power (pi)		13	KW
Average input power (Pi)		13	W
Duty cycle (Du)		0.001	
Pulselength (tp)	0.05	1.0	us
VSWR (6∠)		1.5	
Plate temperature at test point		120	°C





Electrical Characteristics

	Test Condition	Min.	Typ.	Max.	Unit
Heater current	Ef = 6.3V	0.43	0.52	0.6	A
Peak plate voltage	tp = 0.9 - 1.1us Du = 0.001 Ib = 3.0mAdc	3.3	3.5	3.7	KV
Average output power		3.0			W
Frequency		9380	9410	9440	MHz
Spectrum Bandwidth	ib = 2.5 - 3.5A		1.2/tp	2.5/tp	MHz
Missing pulses (stability)				0.25	%
Frequency pulling	σ_4 = 1.3 min.			18	MHz/°C
Temperature coefficient	Tp = 40 - 70 °C			-0.25	MHz
Life		500			hrs

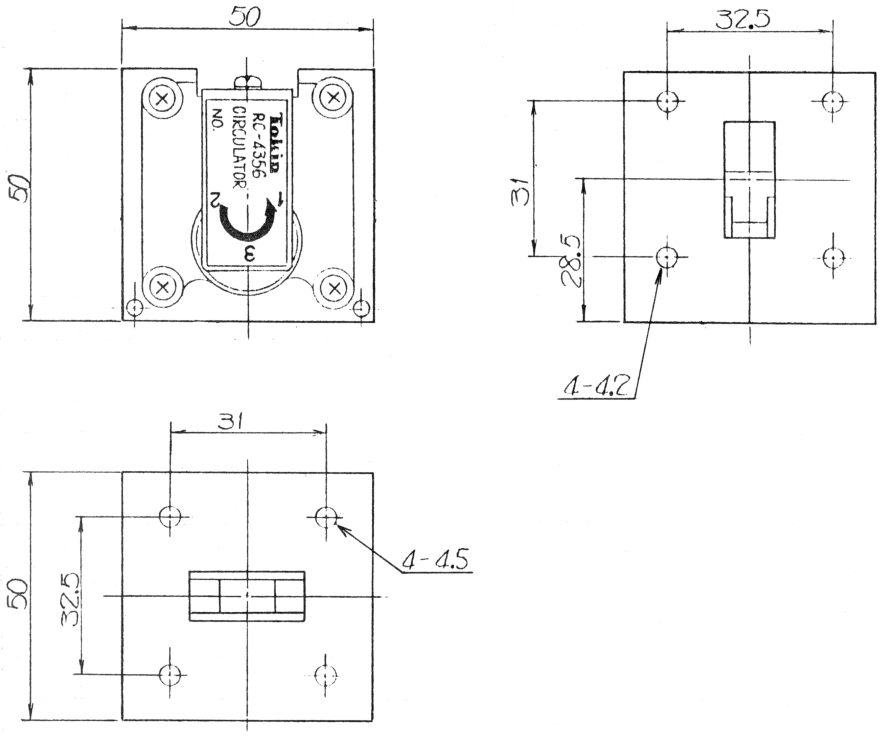
NOTES:
1. Pre-heating time required is 120 seconds minimum for the ambient temperature in excess of 0°C and 180 seconds minimum for 0 to -55°C.
2. Frequency pulling denotes the frequency variation produced in the period of 5 minutes. The measurement is done within 15 minutes after the start of test.
3. The device is defined as its life is over when the average output power drops to 2.4W and the ratio of missing pulses increases to 1% under the test condition stated above.

SPECIFICATIONS OF CIRCULATOR

Type	:RC-4356
Furuno Code No.	:000-106-860
Manufacturer	:Tohoku Kinzoku
Application	:X-band, directional coupling

Electrical Characteristics

Frequency Range	:9300 - 9500MHz
Center Frequency	:9400MHz
Bandwidth	:200MHz
Forward Loss (Ta = 25°C)	:0.3dB or less
Reverse Loss (Ta = 25°C)	:25dB or more
Allowable Average Power	:25W
Allowable Peak Power	:25kW
V.S.W.R.	:1.2 or less



SPECIFICATIONS OF LIMITER

Type	:S-LX5B(S)
Furuno Code No.	:000-107-088
Application	:X-band Limiter

Maximum Ratings at Tc = 25°C

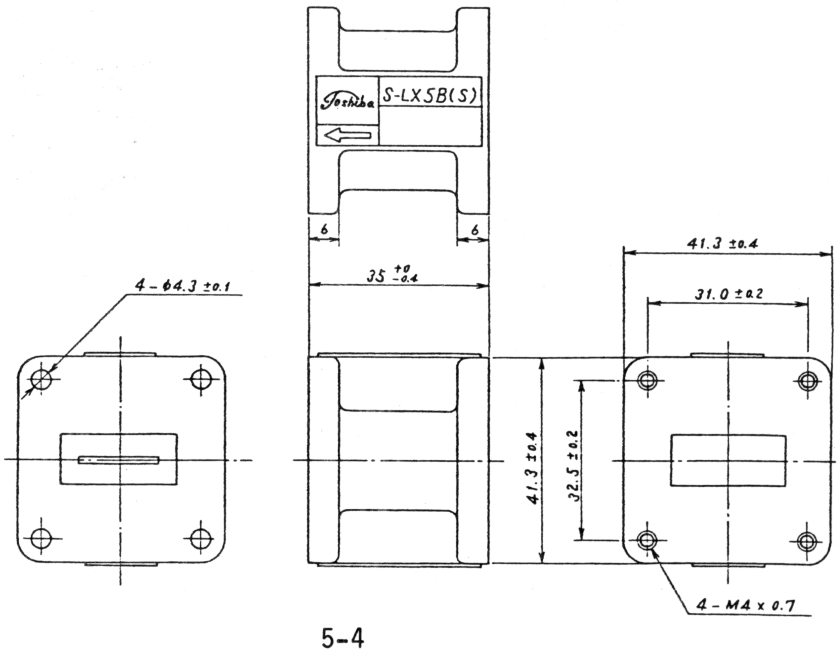
Peak power (see note 1.)	1KW
Average power	2W
Operating temperature	-20 to +70°C
Storage temperature	-30 to +90°C

Electrical Characteristics at Tc=25°C

	Min.	Max.	Unit
Frequency range((see note 2.)	9.3	9.5	GHz
Insertion loss at 9 4GHz (see note 2.)		1.2	dB
VSWR (see note 2.)		1.5	
Flat leakage power (see note 3.)		150	mW
Spike leakage power (see note 3.)		600	mW
Recovery period to -3dB (see note 3.)		0.5	us
Rated power for cont nuous operation (see notes 1 and 4.)		2	kW

Life-over point: When the insertion loss for 0.5mW continuous wave exceeds 3dB.

NOTE:
1. Measured at frequency 9375MHz, pulselength 1us and pulse repetition rate 1000pps.
2. Measured at continuous wave of less than 0.5mW.
3. Measured at peak power 2kW, frequency 9375MHz, pulselength 1us and pulse repetition rate 1000pps.
4. This value is subject to change with pulse length and case temperature.



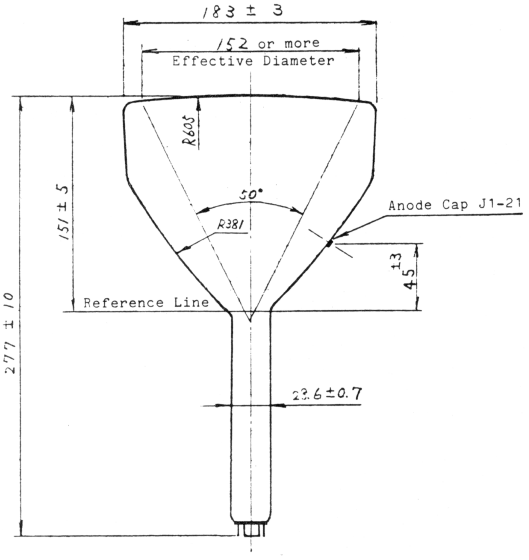
SPECIFICATIONS OF CATHODE RAY TUBE

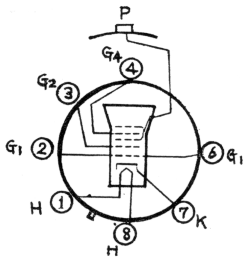
Type :180SB7
Furuno Code No. :000-103-600
Manufacturer :Toshiba

Electrical Characteristics

Type of CRT :Electromagnetic deflection, Electrostatic focus
Deflection Angle :50 degrees
Structure :Round, Metal back
Fluorescent Colour :White
Ratings

Item	Min.	Typ.	Max.	Unit
Heater Volt.	5.7	6.3	6.9	Vdc, ac
1st Grid volt.	-180	-	0	Vdc
2nd Grid Volt.	250	400	550	Vdc
4th Grid volt.	0	-	400	Vdc
Anode volt.	7000	9000	11000	Vdc
Ambient Temp.	-20	-	80	°C





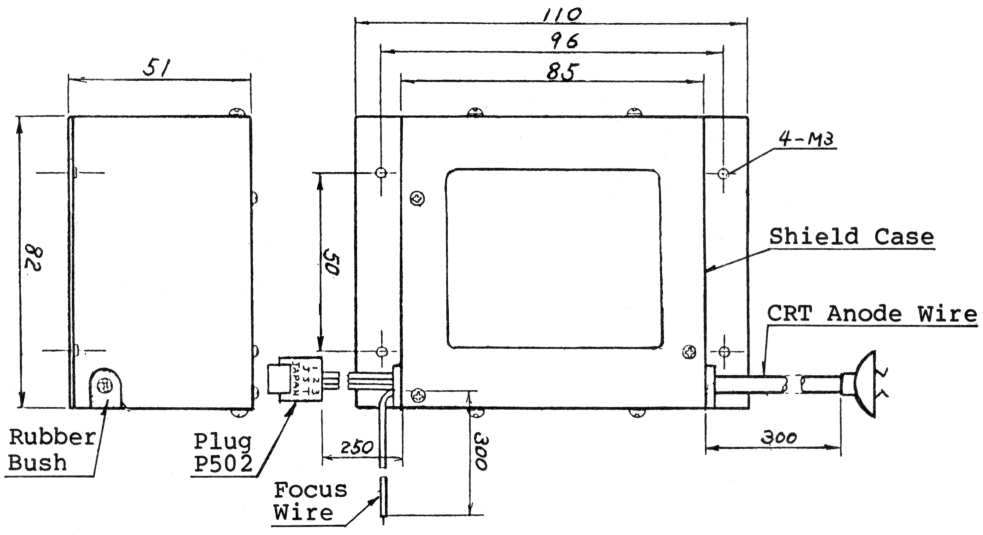
Bottom View

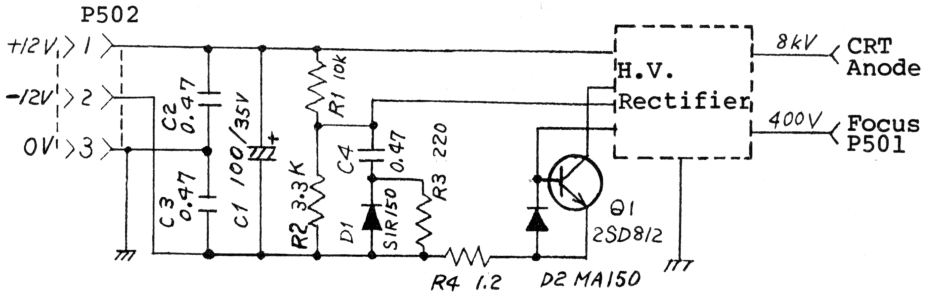
SPECIFICATIONS OF CRT HIGH VOLTAGE POWER SUPPLY

Type :RU-3679-2
Furuno Code No. :000-633-678
Manufacturer :Matsushita

Electrical Characteristics

Item	Min.	Type.	Max.	Unit
Input Voltage	-13.2	±12	+13.2	V
Input Current	-	±160 or less	-	mA
Output Voltage	-	8	9	kV
Output Current	-	70	77	uA
Focus Voltage	-	400	-	V
Output Deviation	-	2.5 or less	-	%
Ripple	-	0.2 or less	-	%
Output Deviation with Temp.	-	± 3 or less	-	%
Storage Temperature	-30	-	+70	°C
Operating Temperature	-20	-	+60	°C



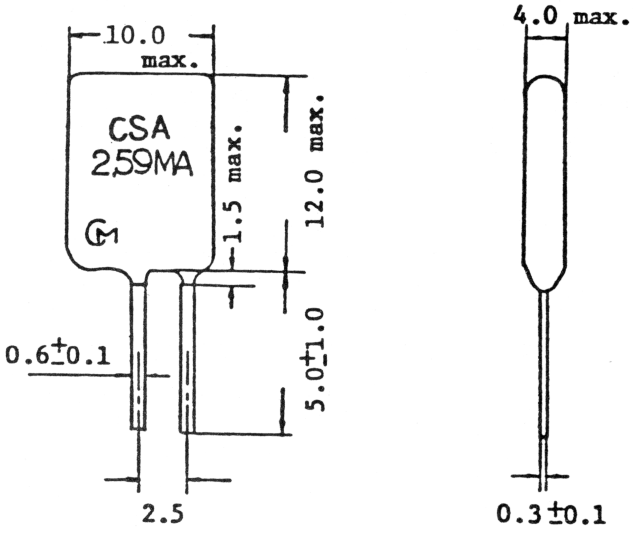


SPECIFICATIONS OF CRYSTAL

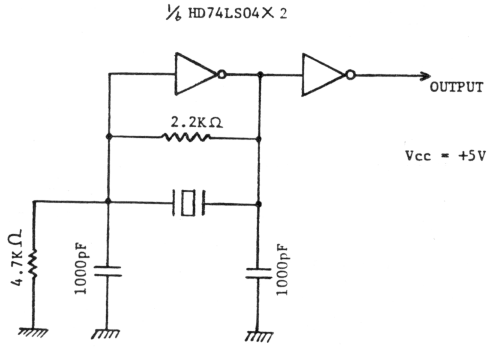
Type	:CSA2.59MA1
Furuno Code No.	:000-491-030
Manufacturer	:Murata

Electrical Characteristics

Oscillation Frequency	:2.59MHz + 0.5%
Frequency Deviation	:Within ±0.3% under temperature range of -20°C to +80°C
Withstand voltage	:DC50V max.



Outline



OSC. Circuit

FURUNO

*** DIODE ***

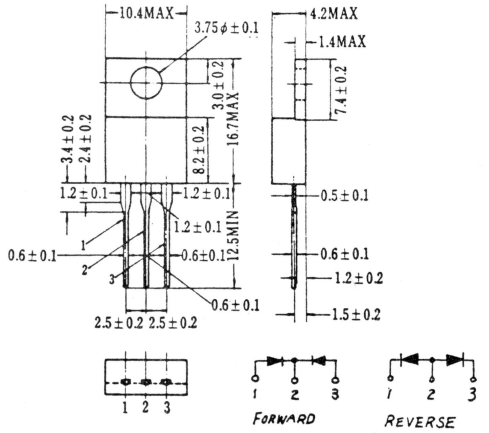
TYPE	CODE NO.	MFR.	APPLI-CATION	CONST-RUCTION	ABSOLUTE MAX RATINGS AT 25°C VRM (V)	VR (V)	VI (V)	IFM (MA)	IO (MA)	IS (A)	FORWARD (25°C) MIN IF (MA)	VF (V)	MAX VF (V)	IF (A)	REVERSE(25°C) MAX IR (UA)	VR (V)	OUT-LINE	NOTE/SUBSTITUTE
CTU-22R	000132445	SKN	R	SI.D	200	140			1.1A	40			2	5	50	200	D-1	
CTU-22S	000132446	SKN	R	SI.D	200	140			1.1A	40			2	5	50	200	D-1	
MA26WO-B	000133739	MAT	TEMP	SI.D				30			3	1.25	1.35				D-2	
SB-2	000135012	SKN	R	SI.D	500		350		1.5A*	100			1.1	1.5	10	500	D-3	*TA=60°C/1S1897
U06C	000135901	HTC	R	SI.D	200				2A	80			1.4	2			D-4	1S2596
V-19E	000136020	HTC	R	SI.D	400				1A	60			1.2	1	10	400	D-5	CATHODE:BLUE
V11J	000136012	HTC	R	SI.D	800				400	25			3	0.4			D-5	
V11N	000136016	HTC	R	SI.D	1500				400	25			3	0.4			D-5	1S2326
1S1588	000112795	TOS	SW	SI.EP	35	30		360	120	0.5			1.3	0.1	0.5	30	D-6	
1S2095A	000113046	TOS	SW	SI.EP	75	70		750	250	1			0.65	1MA	0.1	50	D-6	
1S2462	000113090	TOS	D	SI.PL	220	200		300	100	0.8			1	0.1	1.2	200	D-6	
1N60	000111090	TOS	D	GE.P	45	35		150	50	0.5	4	1			75	10	D-7	

NOTE: VRM=MAXIMUM REVERSE VOLTAGE, VR=MAX DC REVERSE VOLTAGE, VI=MAX AC INPUT VOLTAGE(RMS), IFM=MAX PEAK FORWARD CURRENT, IO=MAX AVERAGE DC OUTPUT CURRENT, IS=MAX FORWARD TRANSIT CURRENT, IF=FORWARD CURRENT, VF=FORWARD VOLTAGE, IR=REVERSE CURRENT, VR=REVERSE VOLTAGE.

*** ZENER DIODE ***

TYPE	CODE NO.	MFR.	APPLI-CATION	CONST-RUCTION	ABS MAX P (MW)	IZ (MA)	ZENER VOLTAGE VZ MIN (V)	AVG (V)	MAX (V)	IZ (MA)	MAX DYNAMIC RESISTANCE RZ (OHM)	IZ (MA)	THERMAL COEFFICIENT OF VZ (% /°C)	REVERSE (25°C) MAX IR (UA)	VR (V)	OUT-LINE	NOTE/SUBSTITUTE
RD10EB	000134816	NEC		SI.PL	400		9.4		10.6	20	10	20		2	7	D-6	
RD22EB	000134840	NEC		SI.EP	400		20.8		24.5	5	60	5		2	17	D-6	
RD30EB	000134855	NEC		SI.EP	400		28.0		34.0	5	130	5		2	23	D-6	
RD33EB	000134860	NEC		SI.EP	400		31.0		37.0	5	160	5		2	25	D-6	
RD6.2EB1	000134833	NEC		SI.PL	400		5.8		7.0	20	20	20		5	3	D-6	
RD6.8FB	000134800	NEC		SI.PL	1		6.4		7.2	40	6	40		20	3.5	D-8	
RD9.1EB1	000134835	NEC		SI.PL	400		8.5		9.6	20	10	20		2	6	D-6	
05Z5.1L	000110801	TOS		SI.PL	500	86	4.8	5.1	5.4	5	50	5	0.030	1	1	D-6	

NOTE: P=MAXIMUM POWER DISSIPATION, IZ=ZENER CURRENT, IR=REVERSE CURRENT, VR=REVERSE VOLTAGE.



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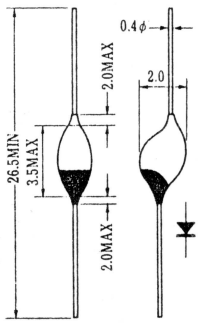

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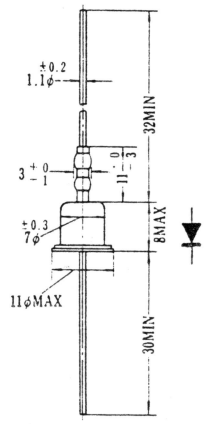

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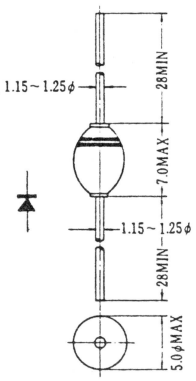

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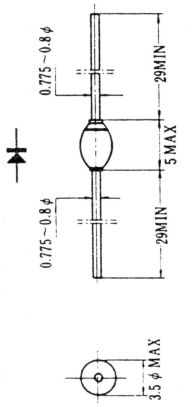

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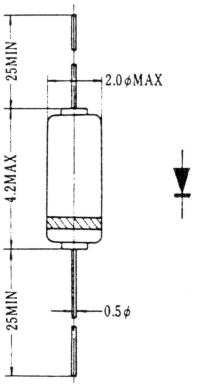

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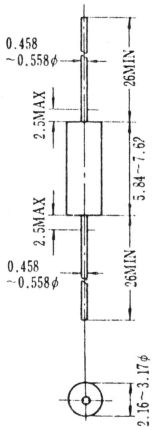

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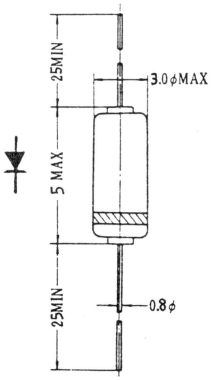


D-8

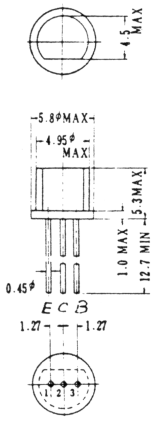
FURUNO

*** TRANSISTOR ***

TYPE	CODE NO.	MFR.	APPLI-CATION	CONST-RUCTION	ABSOLUTE MAX RATINGS AT 25°C VCBO (V)	VEBO (V)	IC (MA)	PC (MW)	TJ (°C)	CHARACTERISTICS(25°C) VCE (V)	IC (MA)	HFE	FT (MHZ)	TO NO.	OUT-LINE	NOTE/SUBSTITUTE
2SA467GTMO	000116930	TOS	RF	SI.EP	-40	-5	-400	400	125	-1	-100	70-140	100		TR-1	COMPLEMENT.2SC367GTM-O
2SA495GTMO	000116992	TOS	RF	SI.E	-50	-5	-150	400	125	-1	-10	70-140	100		TR-1	
2SA495GTMY	000116993	TOS	RF	SI.E	-50	-5	-150	400	125	-1	-10	120-240	100		TR-1	
2SA715WTC	000117430	HTC	RF	SI.EP	-35	-5	-2.5A	10W*	150	-2	-500	100-200	160		TR-2	* AT TC=25°C
2SA733	000117445	NEC	RF.AF	SI.E	-60	-5	-100	250	125	-6	-1	200	180		TR-3	
2SA778K	000117520	HTC	RF	SI.TD	-150	-5	-50	200	125	-3	-15	100	50		TR-4	
2SB434-Y	000120871	TOS	PA	SI.EME	-50	-5	-3A	25W*	150	-5	-500	120-240	10		TR-5	* AT TC=25°C
2SB595-O	000121103	TOS	PA	SI.T	-100	-5	-5A	40W*	150	-5	1A		5		TR-5	* AT TC=25°C
2SC1569	000125117	TOS	PA	SI.TP	300	5	150	1.5W	150	10	50	40-170	100		TR-5	
2SC2334-6K	000126152	NEC	Sw	SI	150	7	7A	1.5W	150			100-200			TR-6	
2SC2837-O	000126301	SKN		SI	150	5	10A	100W	150			50-100	70		TR-7	
2SC367GTMO	000123552	TOS	RF.CONV	SI.EP	40	5	400	400	125	1	100	70-140	120		TR-1	COMPLEMENT.2SA467GTM-O
2SC372GTMY	000123561	TOS	RF.CONV	SI.E	60	5	150	400	125	12	2	120-240	200		TR-1	
2SC606-BL	000123910	NEC	RF	SI.P	30	4	20	150	150	10	2	70	530		TR-8	
2SC752GTMO	000124129	TOS	RF	SI.EP	40	5	200	400	125	1	100	70-140	400		TR-1	
2SC945	000124420	NEC	RF.AF	SI.E	60	5	100	250	125	6	1	200	250		TR-3	

NOTE: VCBO=COLLECTOR-BASE VOLTAGE (EMITTER OPEN), VEBO=EMITTER-BASE VOLTAGE (COLLECTOR OPEN), IC=COLLECTOR CURRENT,
PC=POWER DISSIPATION, TJ=JUNCTION TEMPERATURE, VCE=COLLECTOR-EMITTER VOLTAGE, IC=COLLECTOR CURRENT,
HFE=STATIC FORWARD CURRENT TRANSFER RATIO, FT=TRANSITION FREQUENCY.

MANUFACTURER(MFR.): FUJ=FUJITSU, HTC=HITACHI, IRJ=INTERNATIONAL RECTIFIER (JAPAN), MAT=MATSUSHITA, MOT=MOTOROLA, MTB=MITSUBISHI,
NEC=NIPPON ELECTRIC, NJR=NEW JAPAN RADIO, OKI=OKI ELECTRIC, ORG=ORIGIN ELECTRIC, SKN=SANKEN ELECTRIC,
SND=SHINDENGEN ELECTRIC, SON=SONY, STL=STANLEY ELECTRIC, SYO=SANYO, TOS=TOSHIBA, FJD=FUJI ELECTRIC



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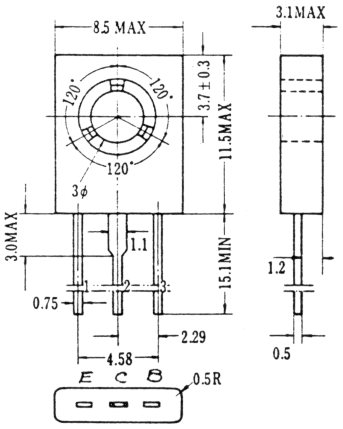
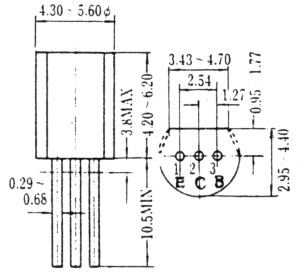


TR-2



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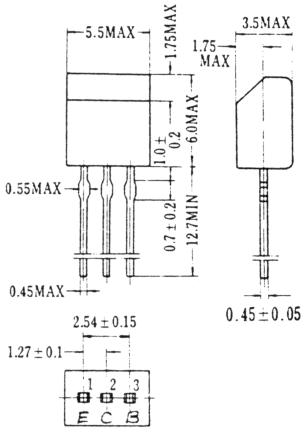
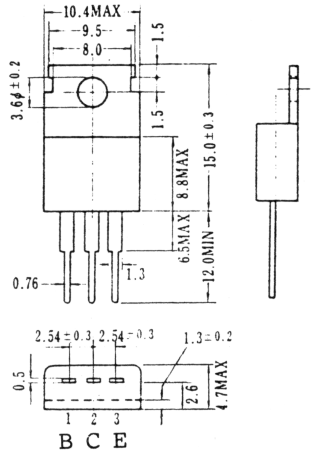


TR-4



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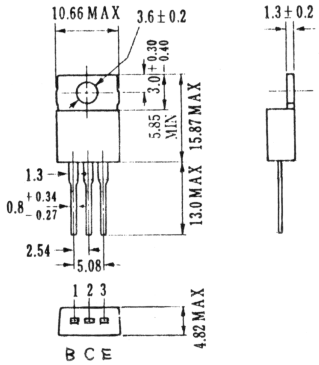

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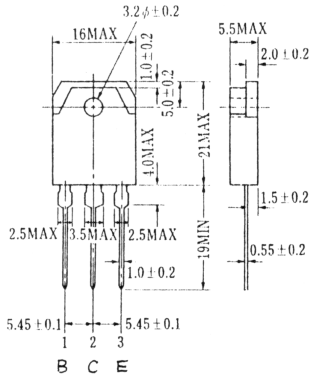

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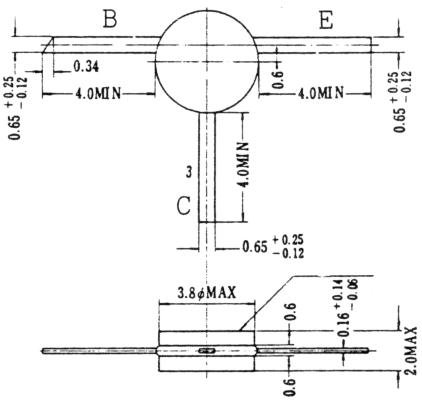
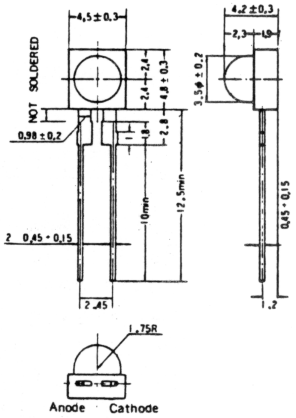


TR-8

SPECIFICATIONS OF LED

Type	:LN35BP
Furuno Code No.	:000-133-609
Manufacturer	:Matsushita



Electrical Characteristics

Absolute Maximum Ratings (Ta = 25°C)

Reverse Voltage	:4V
Forward Current (IF)	:30mA
Power Dissipation	:90mW
Operating Temperature	:-25 to +85°C

Electro-optical Characteristics (Ta = 25°C)

Luminous Intensity	:0.7mcd (min.) at IF=20mA
Forward Voltage	:2.8V (max.) at IF=20mA

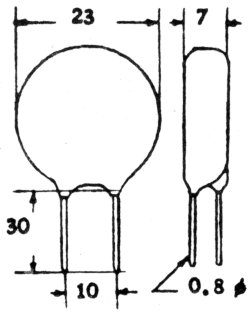
Colour :Blue

SPECIFICATIONS OF VOLTAGE REFERENCE DIODE

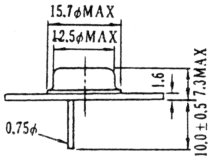
Type	:ERZ-15D3K221
Furuno Code No.	:000-132-669

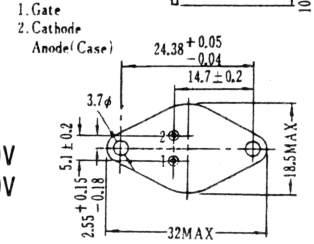
Electrical Characteristics

Maximum Power	:1.5W
Zener Voltage (Vx)	:220V ± 10%
Voltage Deviation Ratio (V10/V1)	:1.08 max. (V10:Vx at 10mA, V1:Vx at 1mA)
Operating Temperature	:-20 to +120°C



SPECIFICATIOINS OF SCR





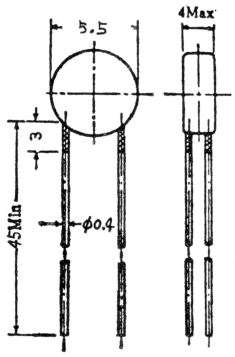
Type :S6080B
Furuno Code No. :000-135-000

Electrical Characteristics

Absolute Maximum Ratings

Repetitive Peak off-state Volt.	:750V
Non-repetitive Peak off-state Volt.	:800V
Repetitive Peak Reverse Volt.	:5V
On-state Current Total rms Value	:5A
On-state Current w/Alternating comp.	:3.2A (dc value)
Surge On-state Current	:70A (60Hz)
Critical Rate of Rise of On-state Current	:200A/us
Peak Gate Power Dissipation	:25W
Average Gate Power Dissipation	:0.5W
Peak Gate Voltage	:-35V
Junction Temperature	:-40 to +100°C
Storage Temperature	:-40 to +150°C

SPECIFICATIONS OF THERMISTOR

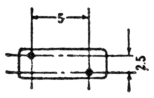


Type :D-22A
Furuno Code No. :000-180-617

Electrical Characteristics

Maximum Ratings

Withstanding Current	:80mA
Operating Current	:5mA
Operating Voltage	:1V
Operating Temperature	:-20 to +70°C

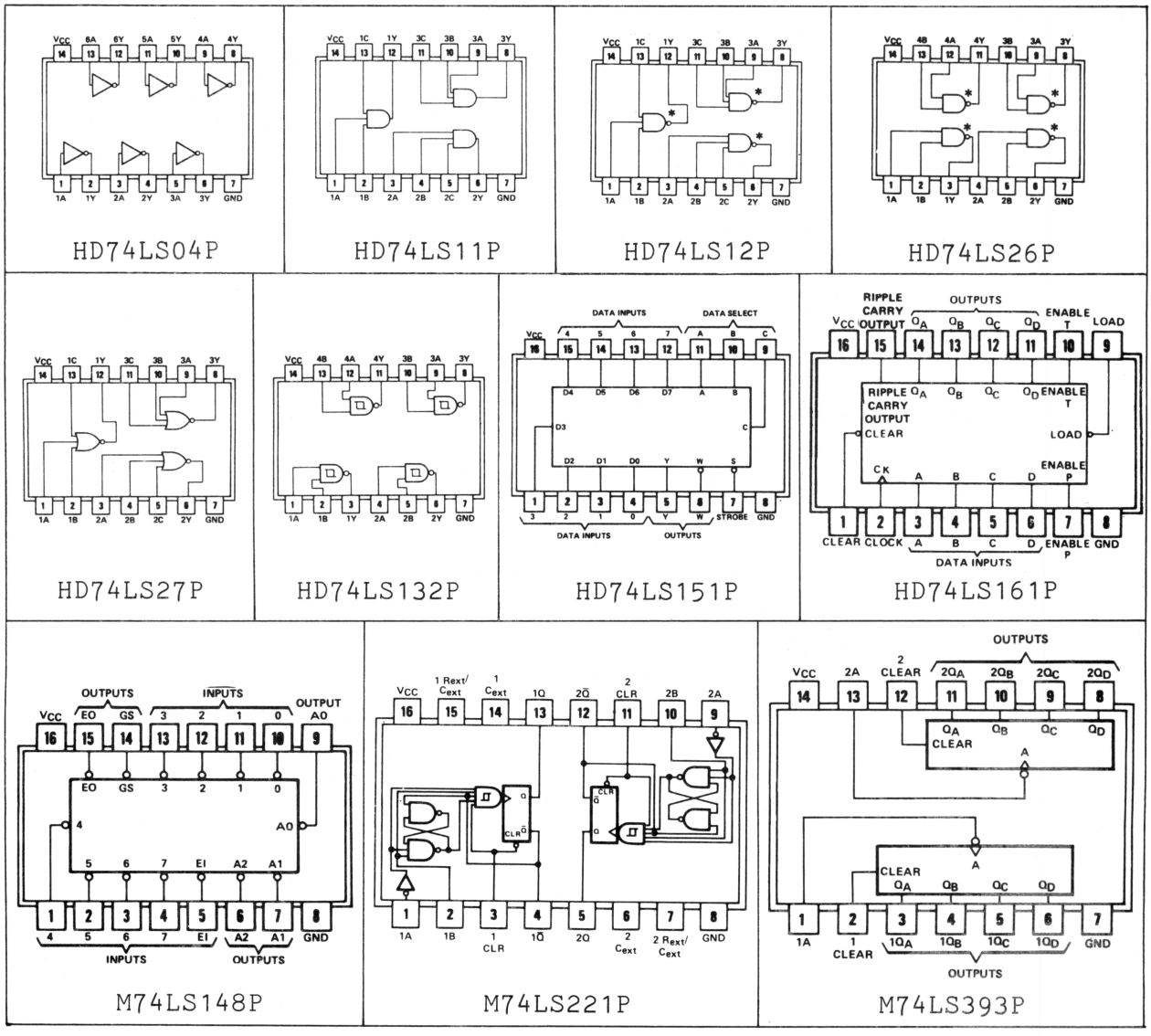


Resistance at Ta = 25°C	:170 to 225ohms
Material Constant	:2950 to 3550°K
Heat Dissipation Constant	:5.5mW/°C
Temperature Coefficient	:-3.3 to -4.0%/°C

SPECIFICATIONS OF DIGITAL IC (TTL Low-power Schottky)

Type	Code No.	Manuf.	Function	Replacement
HD74LS04P	000-162-404	Hitachi	Hex Inverters	SN74LS04
HD74LS11P	000-162-411	Hitachi	Tri 3 Input AND	SN74LS11
HD74LS12P	000-162-412	Hitachi	Tri 3 Input O.C.NAND	SN74LS12
HD74LS26P	000-162-426	Hitachi	Quad 2 Input O.C.NAND Buffers	SN74LS26
HD74LS27P	000-162-427	Hitachi	Tri 3 Input NOR	SN74LS27
HD74LS132P	000-162-485	Hitachi	Quad 2 Input NAND Schmitt Trig.	SN74LS132
HD74LS151P	000-162-510	Hitachi	8 to 1 Data Selector	SN74LS151
HD74LS161P	000-162-516	Hitachi	Synchro. Presettable 4-Bit counter	SN74LS161A
M74LS148P	000-151-218	Mitsubishi	8 to 3 Priority Encoder	SN74LS148
M74LS221P	000-151-219	Mitsubishi	Dual Single Shot	SN74LS221
M74LS393P	000-151-220	Mitsubishi	Dual 4-Bit Binary counters	SN74LS393

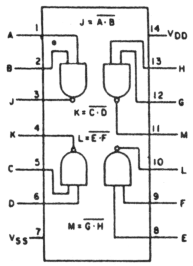
Logic Diagram of TTL Digital IC



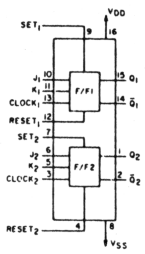
SPECIFICATIONS OF DIGITAL IC (C-MOS)

Type	Code No.	Manuf.	Function	EIA/JEDEC STD.
TC4011BP	000-163-245	Toshiba	Quad 2-input NAND	4011B
TC4027BP	000-163-251	Toshiba	Dual JK-FFs with S/R	4027B
TC4051BP	000-163-257	Toshiba	Single 8-ch. Multiplexer	4051B
MC14538BCP	000-170-016	Motorola	Dual Monostable Multi	4538B
MC14541BCP	000-170-018	Motorola	Programmable Timer	4541B

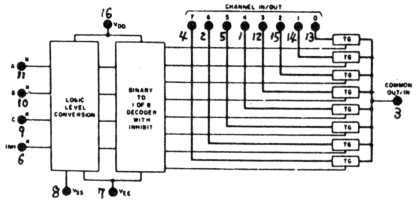
Logic Diagram of C-MOS Digital IC



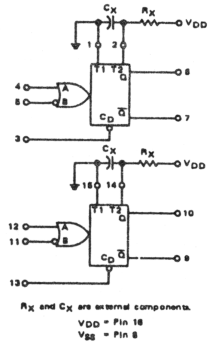
TC4011BP



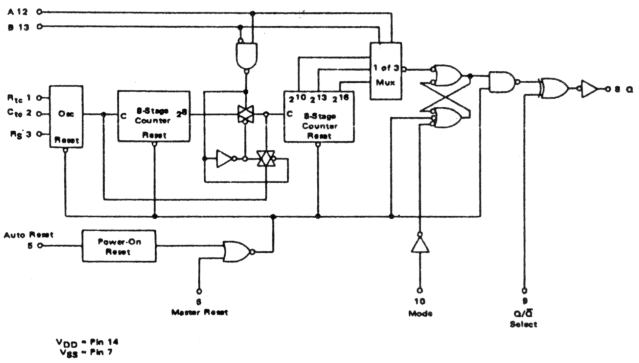
TC4027BP



TC4051BP



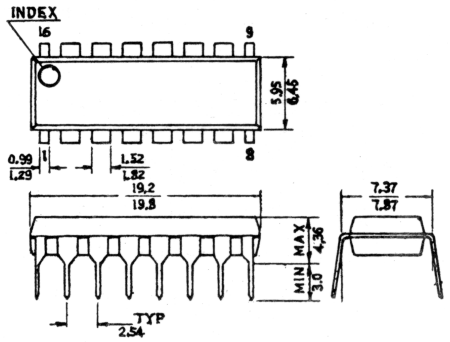
MC14538BCP



MC14541BCP

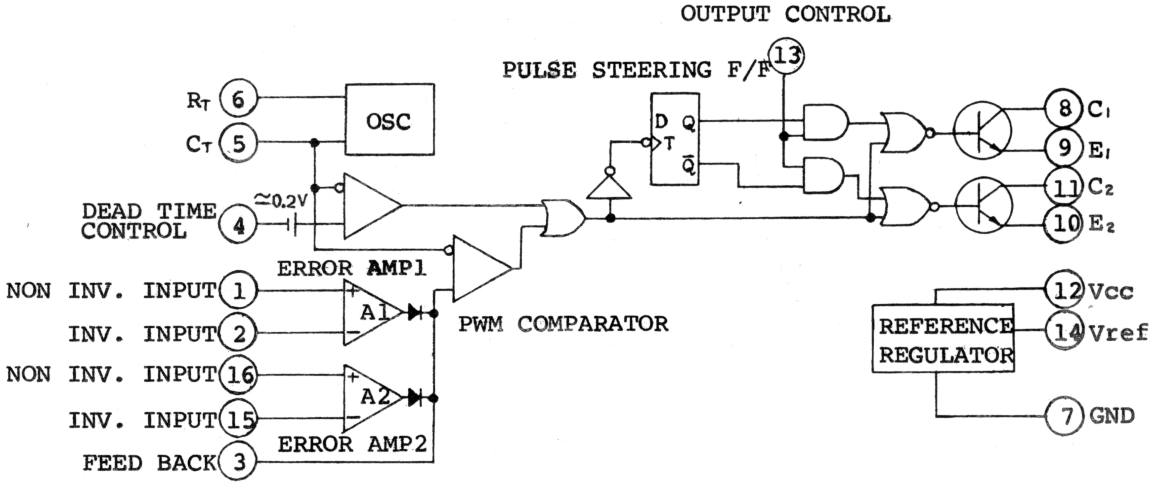
SPECIFICATIONS OF LINEAR IC (Switching Regulator Control Circuit)

Type :MB3759M
Furuno Code No. :000-157-500
Manufacturer :Fujitsu



Electrical Characteristics

Parameter	Min.	Typ.	Max.	Unit
Input voltage (Vcc)	7	15	40	V
Collector Output voltage (Vce)			40	V
Collector Output Current (Ice)			200	mA
Amp. Input voltage (Vin)	-0.3		Vcc-2	V
FB Term. Input Current (Isink)			0.3	mA
Output Current (Iref)			10	mA
Timing Resistance (Rt)	1.8	30	500	kohm
Timing Capacitance (Ct)	470	1000	10^6	pF
Osc. Frequency (fosc)	1	40	300	kHz
Operating Temperature (Top)	0	25	70	°C



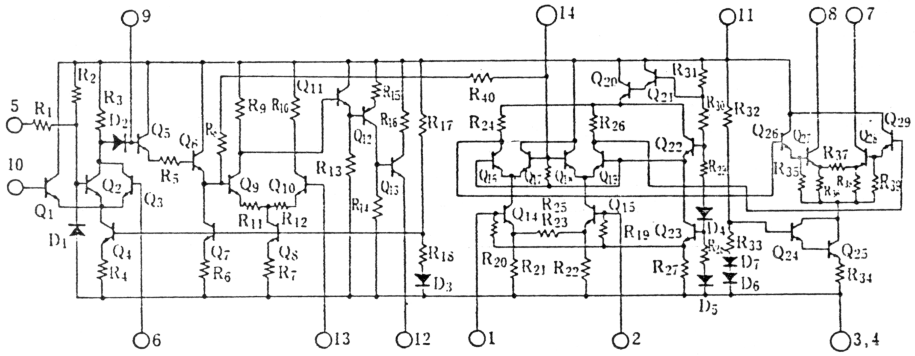
BLOCK DIAGRAM

SPECIFICATIONS OF LINEAR IC (TV Video IF Amp.)

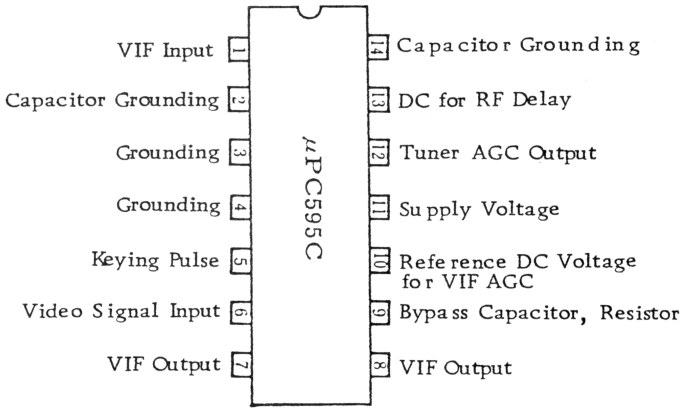
Type :μPC595C
Furuno Code No. :000-161-060

Absolute Maximum Ratings at Ta=25°C

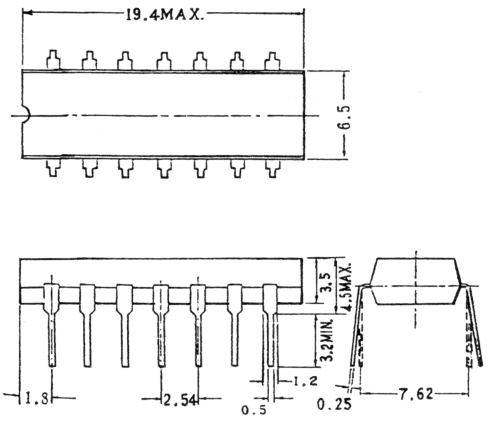
Supply voltage to pin 11	18V
Supply voltage to pins 7 and 8	18V
Input voltage between pins 1 and 2	10V
Supply voltage to pins 6 and 10	6V
Input voltage to pin 5	+10, -20V
Power consumption	400mW at Ta=70°C
Operating temperature	-20 to +70°C
Storage temperature	-40 to +125°C



EQUIVALENT CIRCUIT



CONNECTION DIAGRAM (TOP VIEW)



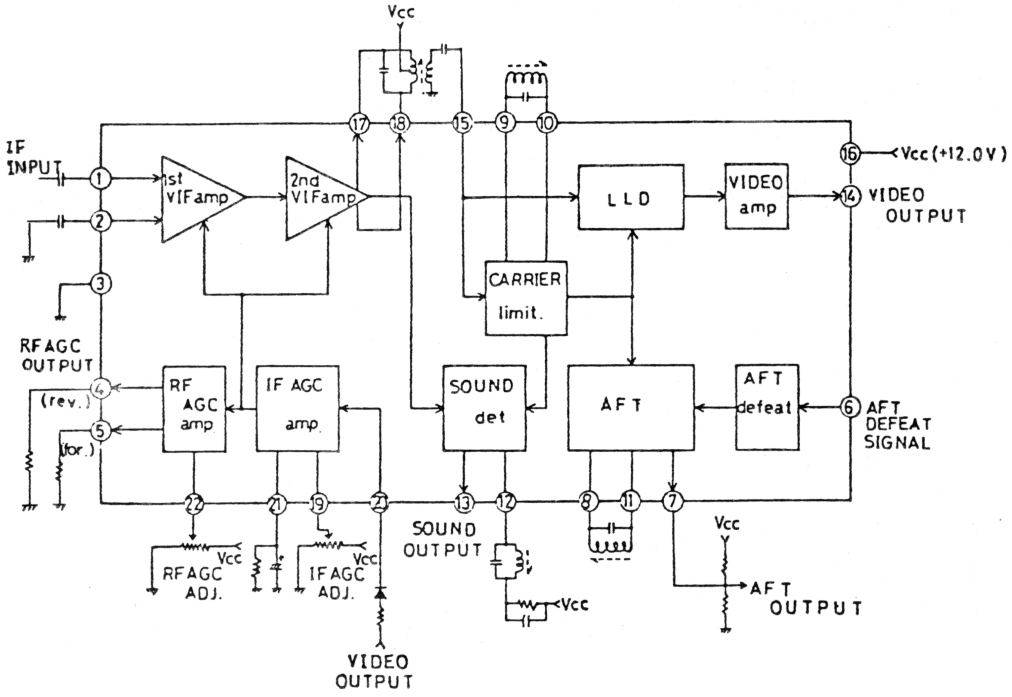
OUTLINE

SPECIFICATIONS OF LINEAR IC (TV IF Sig. Processing)

Type :M5186P
Furuno Code No. :000-150-284
Application :TV IF Amp, Video Detector, Auto Freq. Control

Absolute Maximum Ratings (Ta = 25°C)

Supply Voltage :16V
Power Dissipation :1.4W
Operating Temperature :-20 to +75°C
Storage Temperature :-40 to +125°C



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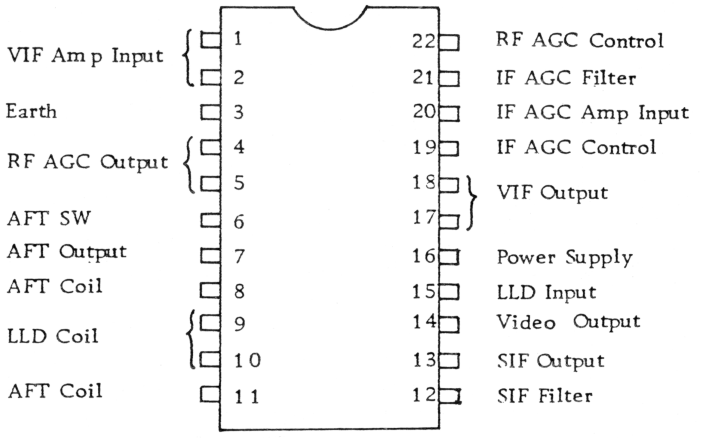
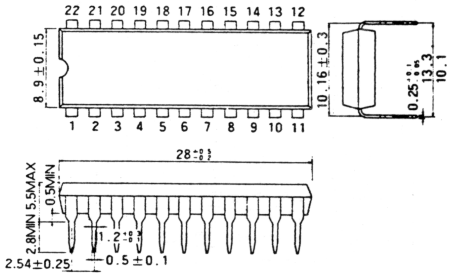


CONNECTION DIAGRAM (TOP VIEW)



SPECIFICATIONS OF LINEAR IC (OP Amp.)

Type	HA17902P	TL081CP	μPC157C
Code number	000-162-082	000-168-486	000-161-031
Manufacturer	HITACHI	T.I.	NEC
Substitute	LM2902		LM301

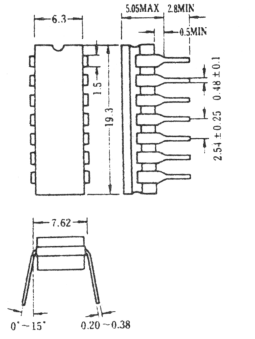
Maximum Ratings

Supply Voltage (Vcc)	28V	±18V	±18V
Power Dissipation (P_D)	625mW	625 to 680mW	500mW
Operating Voltage (Topt)	-40 to +85°C	0 to 70°C	-15 to +80°C
Input Voltage (V_I)	-0.3 to +28V	-15V to +15V	-15 to +15V

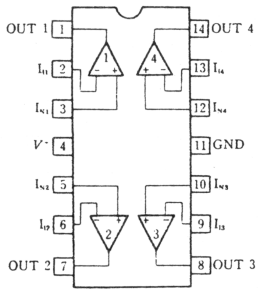
Characteristics

Large Signal Voltage Gain (Av)	90dB		109dB
Slew Rate (SR)	0.6v/us	13v/us	0.5v/us

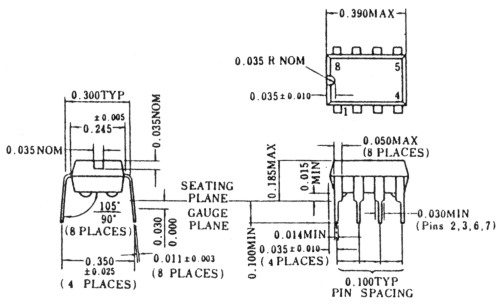
HA17902P

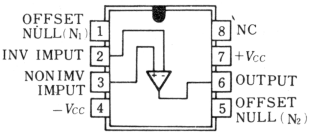


Unit in mm



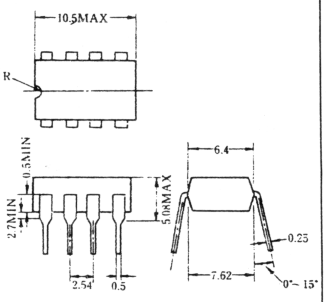
TL081CP

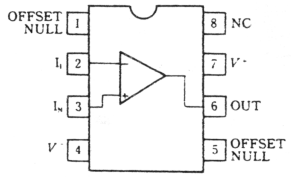




Unit in inch

μPC157C





Unit in mm

CHAPTER 6. PARTS LOCATION

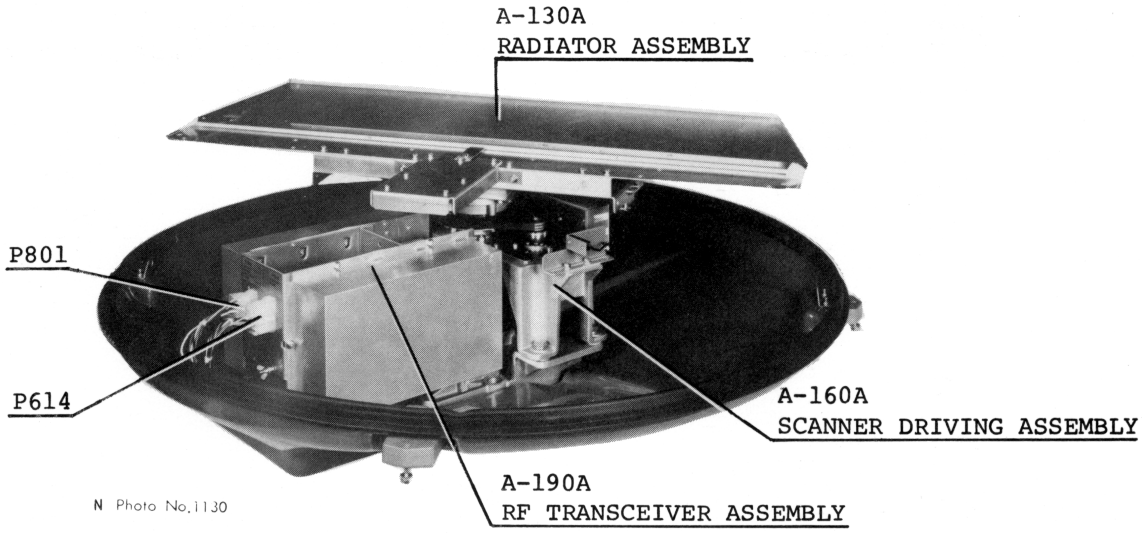


Fig.6-1 Scanner Unit with RF Transceiver Assy.

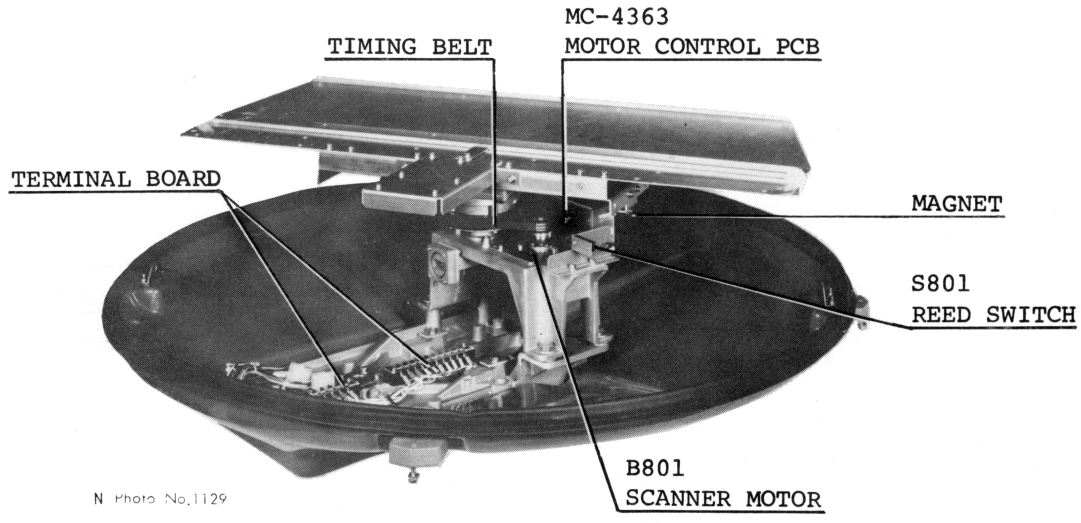


Fig.6-2 Scanner Unit without RF Transceiver Assy.

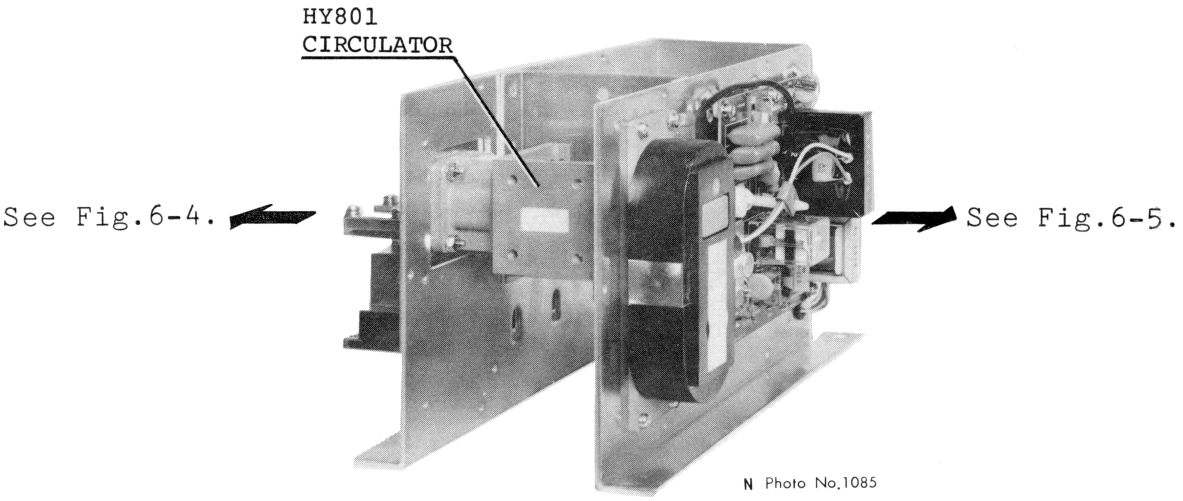


Fig.6-3 RF Transceiver Assembly

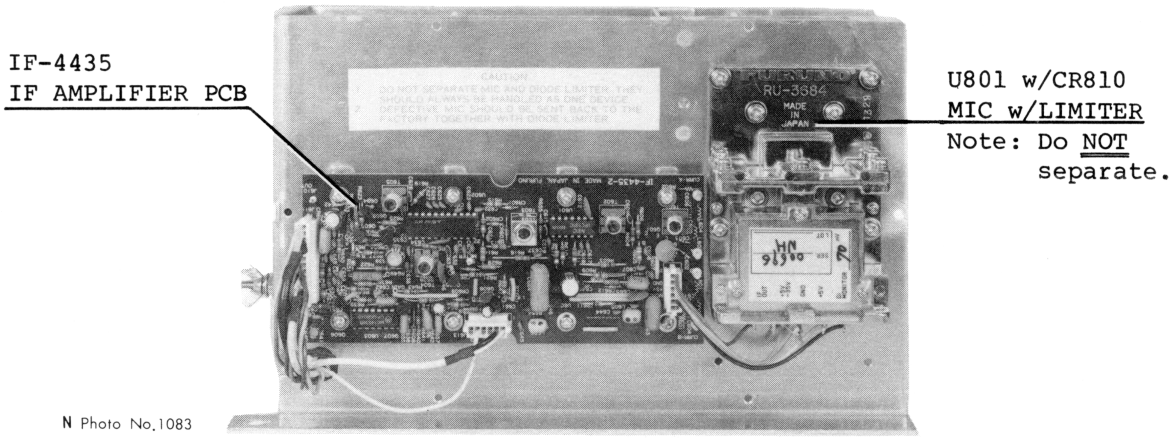


Fig.6-4 Side View of RF Transceiver Assy.

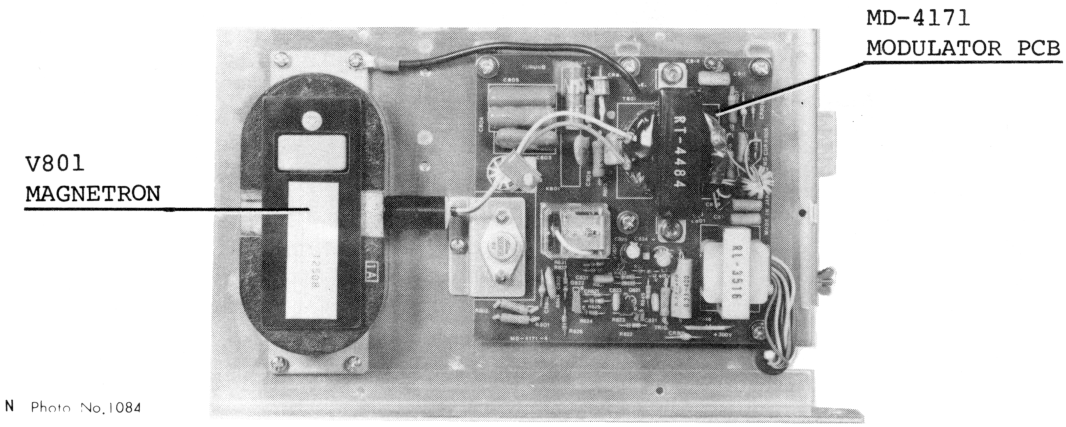


Fig.6-5 Side View of RF Transceiver Assy.

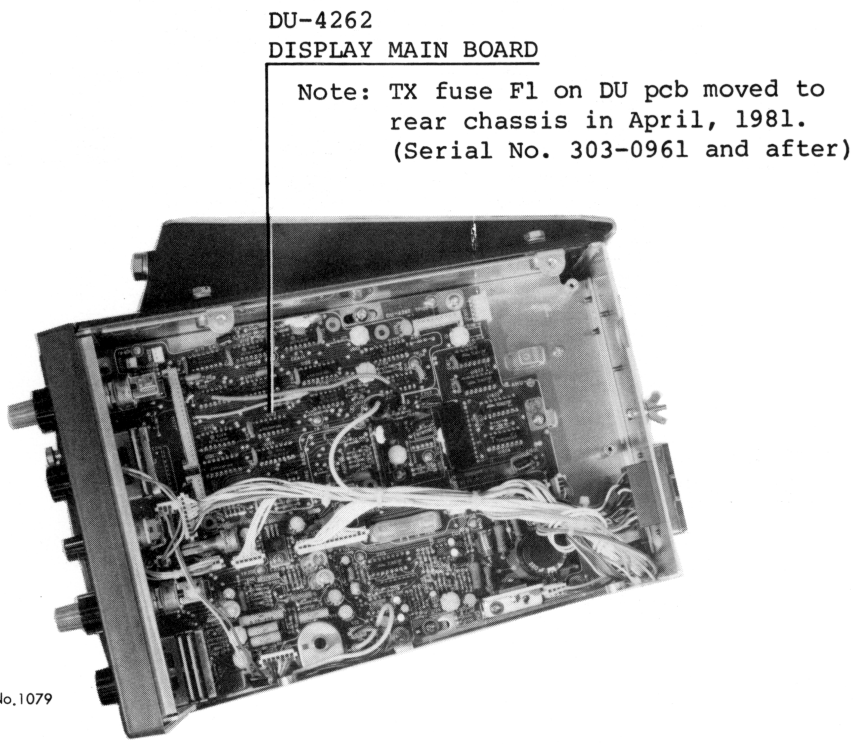

DU-4262
DISPLAY MAIN BOARD
Note: TX fuse F1 on DU pcb moved to
rear chassis in April, 1981.
(Serial No. 303-0961 and after)
N Photo No.1079

Fig.6-6 Display Unit Right-side View

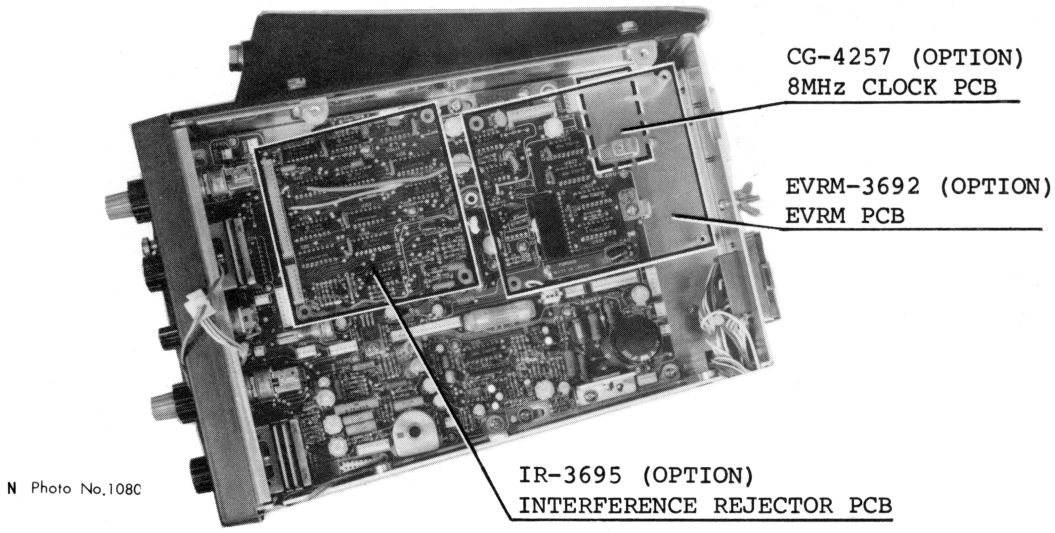


Fig.6-7 Location of Optional P.C.Boards

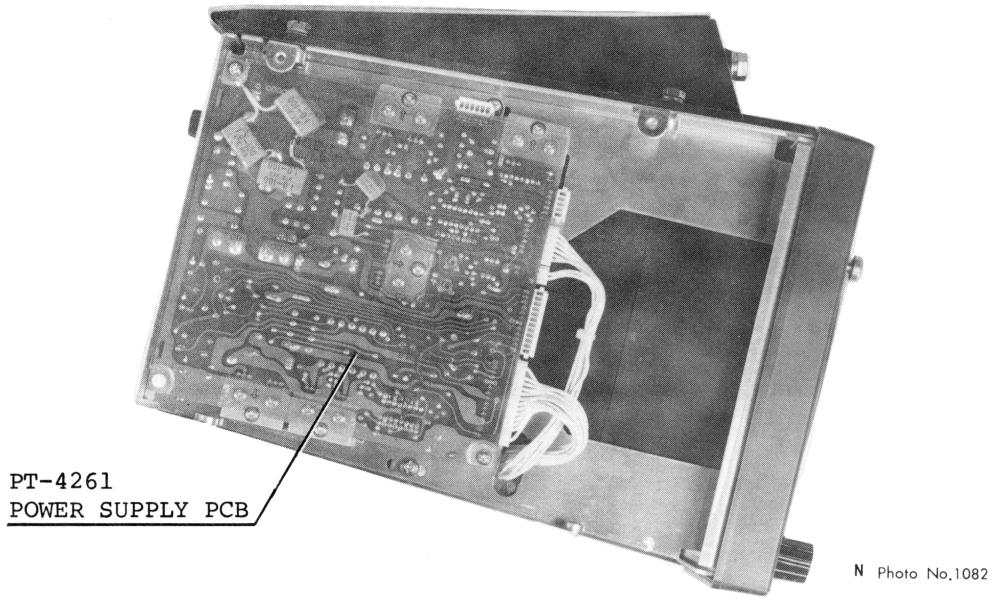


Fig.6-8 Display Unit Left-side View

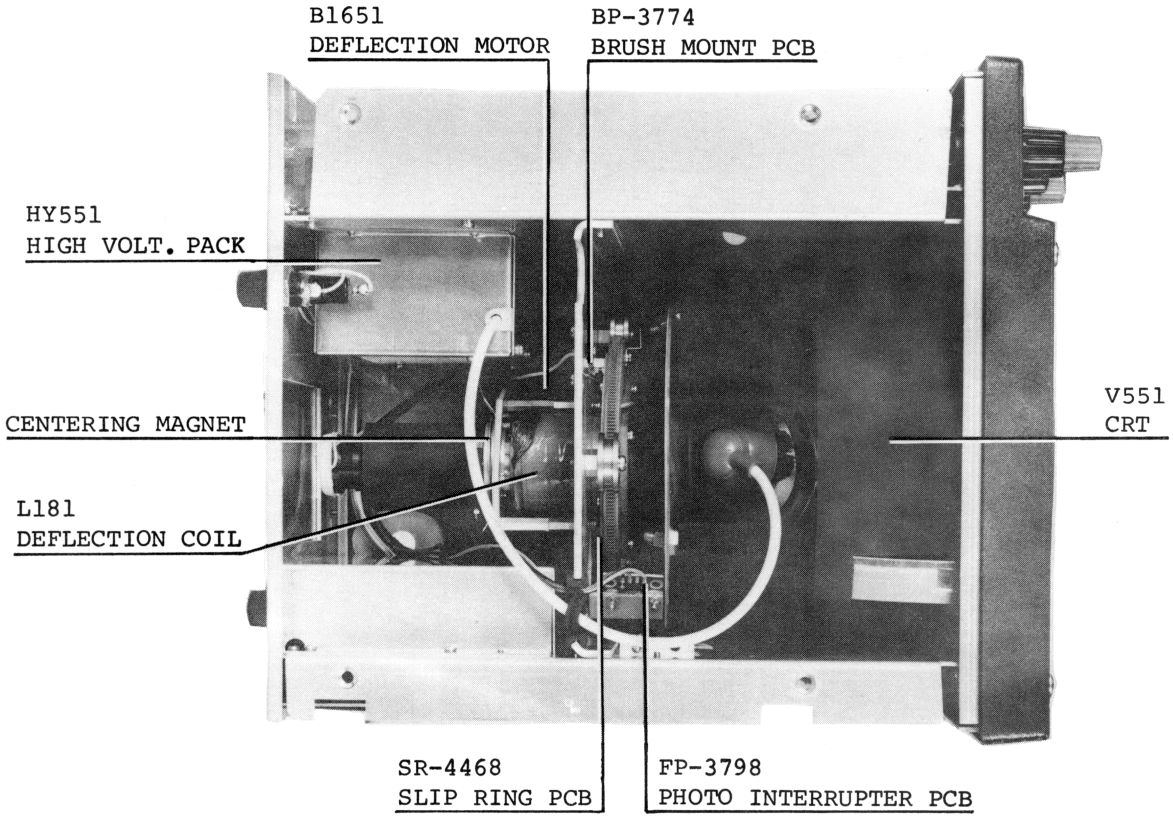


Fig.6-9 Display Unit Top View

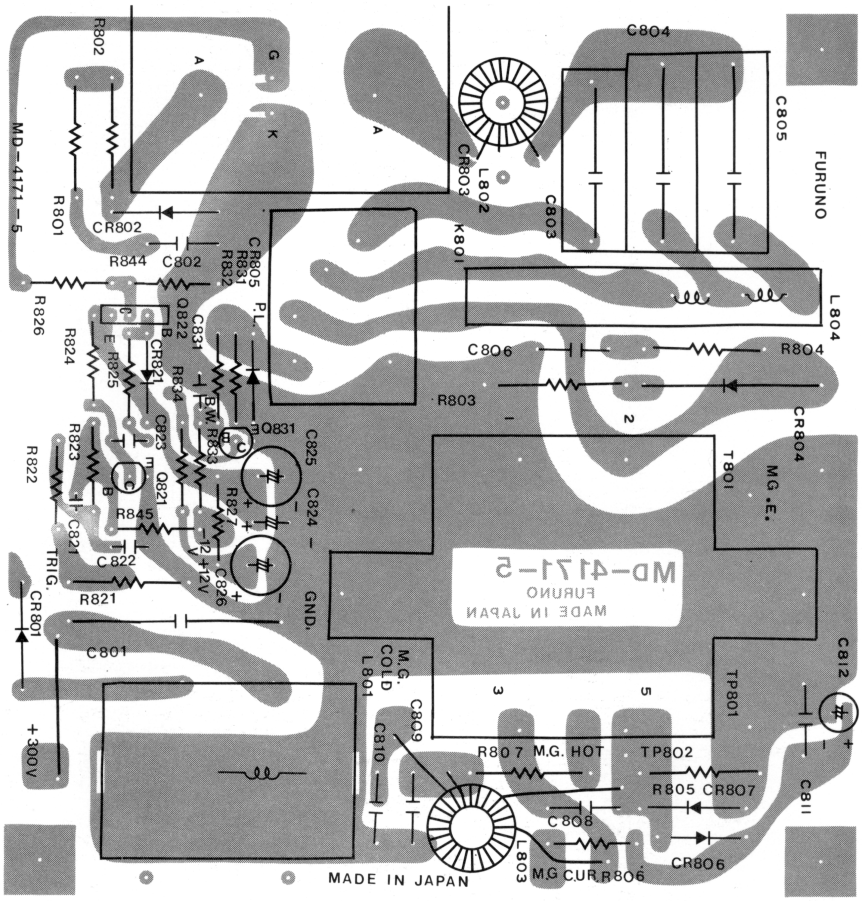


Fig.6-10 MD-4171 MODULATOR PCB in Scanner Unit

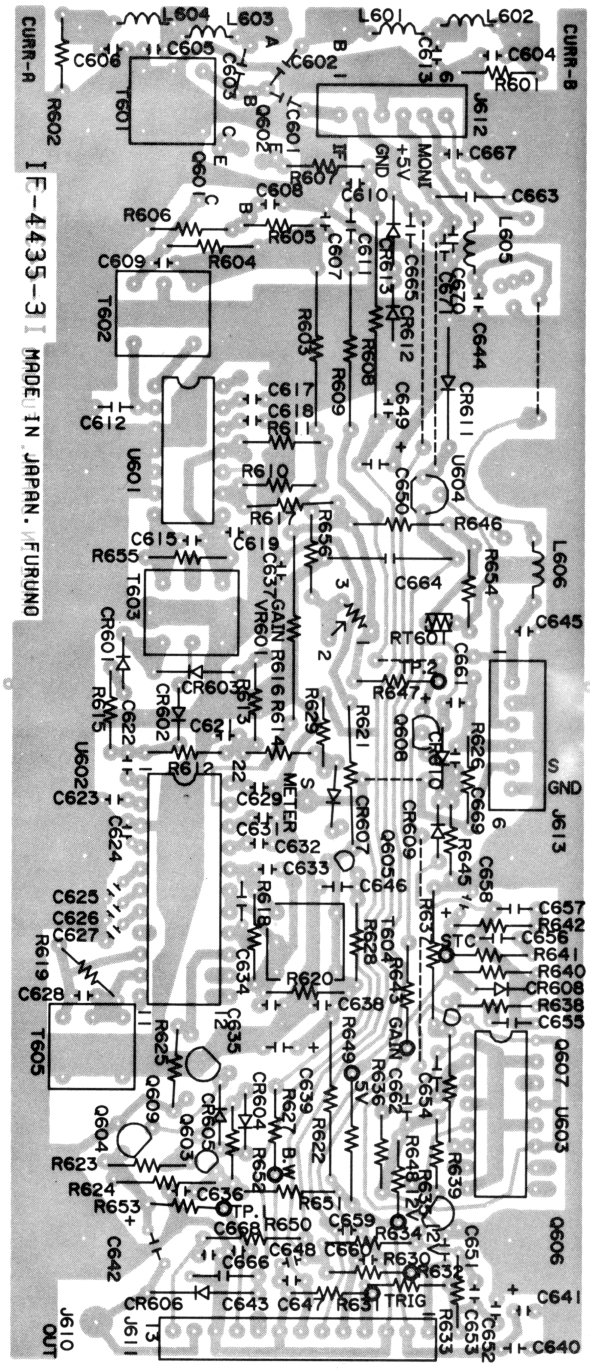


Fig.6-11 IF-4435 IF AMPLIFIER PCB in Scanner Unit

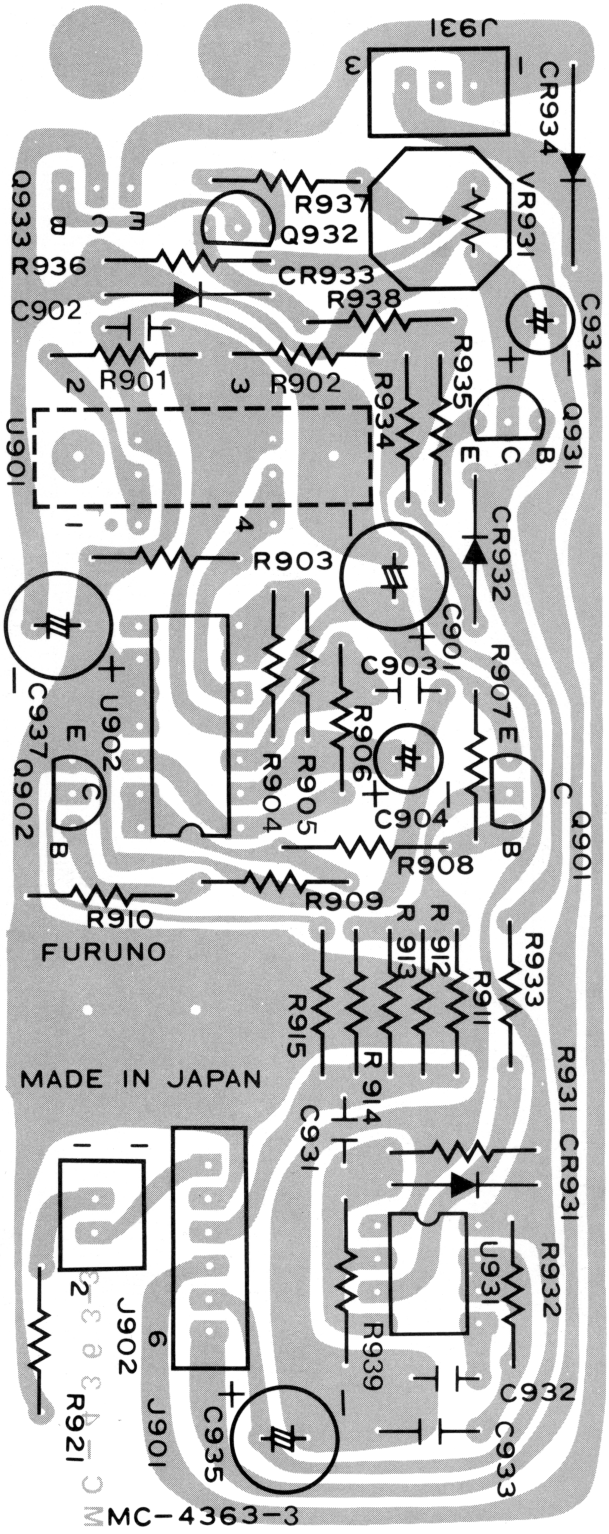


Fig.6-12 MC-4363 MOTOR CONTROL PCB in Scanner Unit

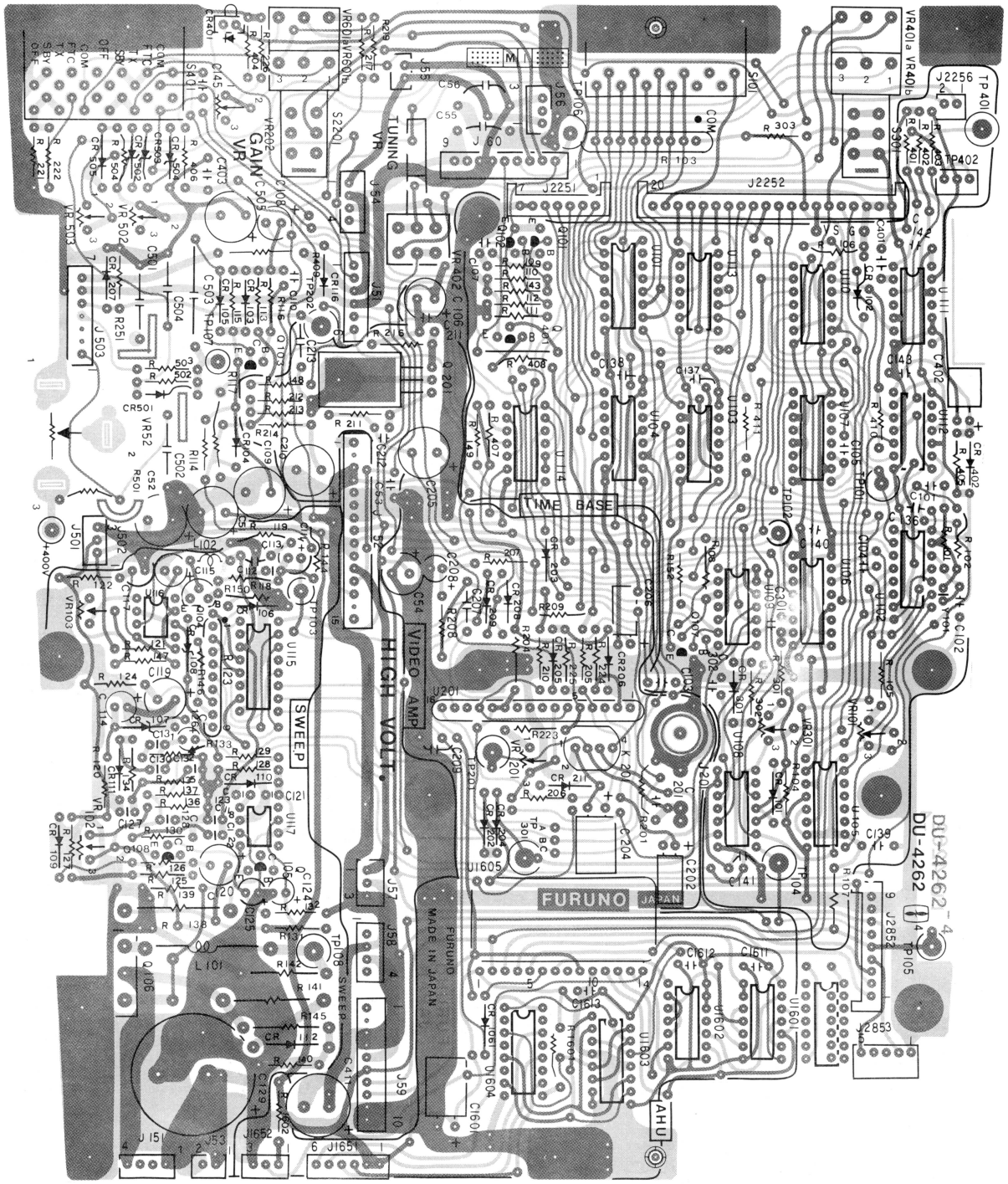


Fig.6-13 DU-4262 DISPLAY MAIN BOARD in Display Unit

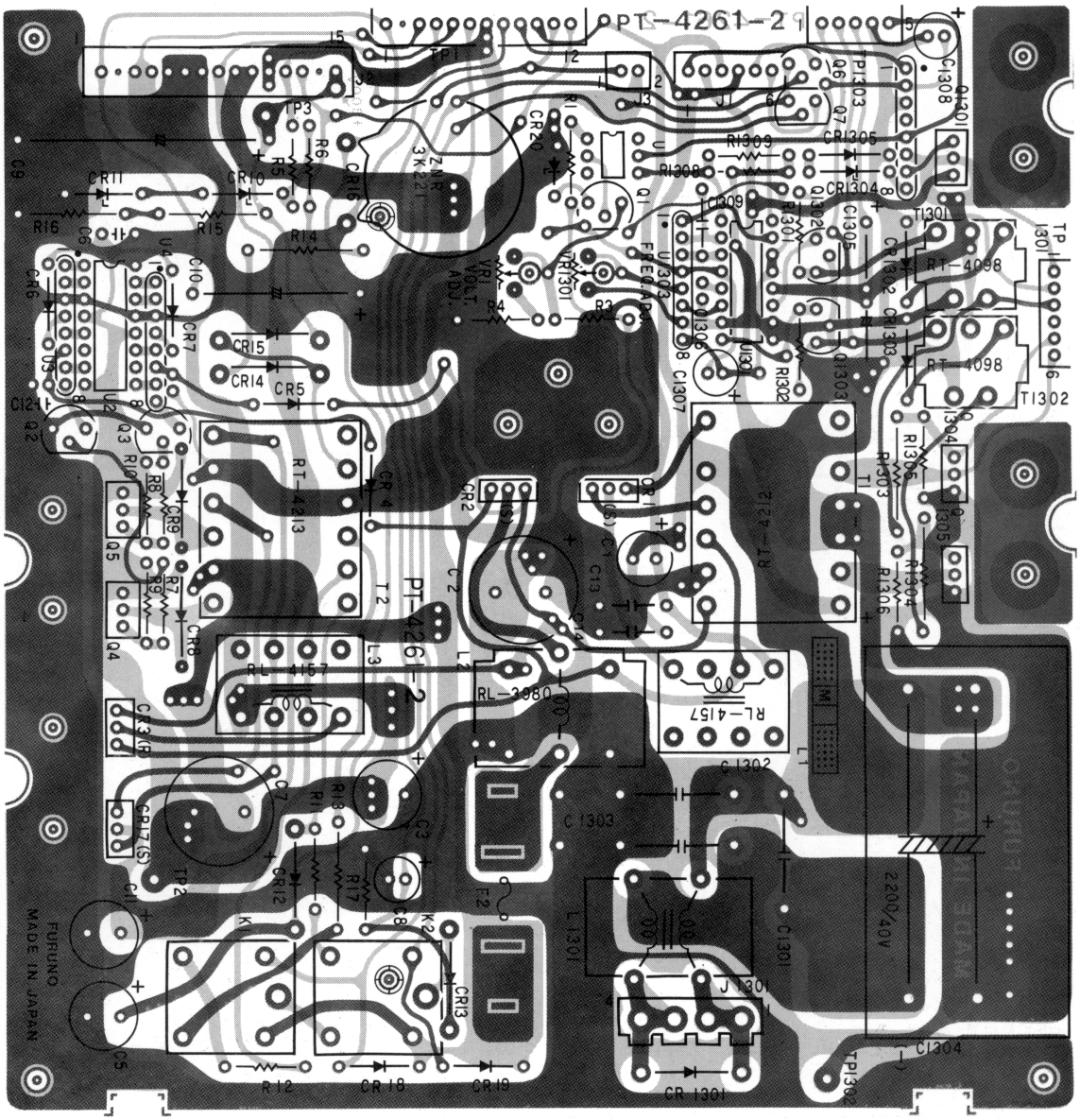


Fig.6-14 PT-4261 POWER SUPPLY in Display Unit

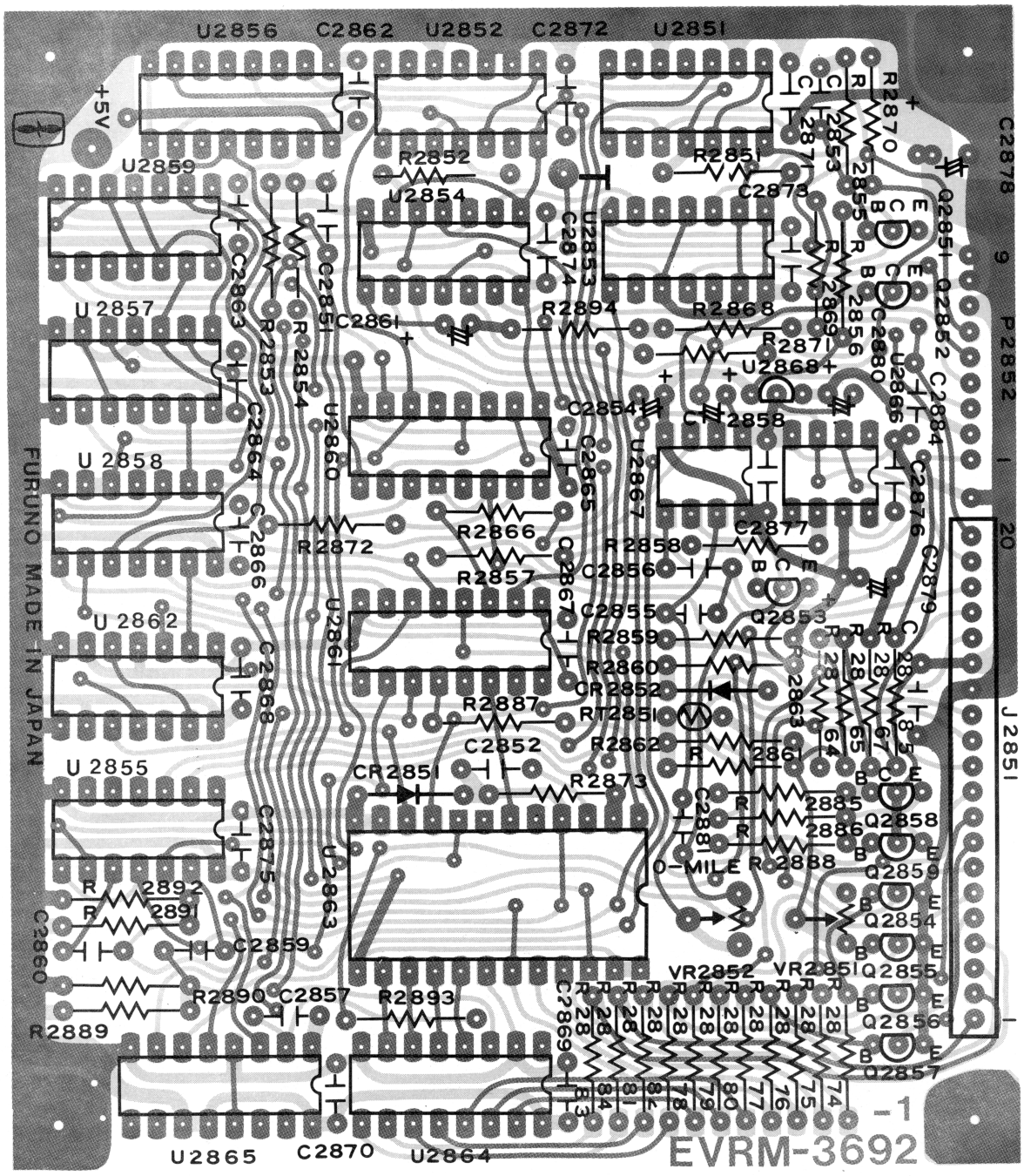


Fig.6-15 EVRM-3692 EVRM PCB (Option)

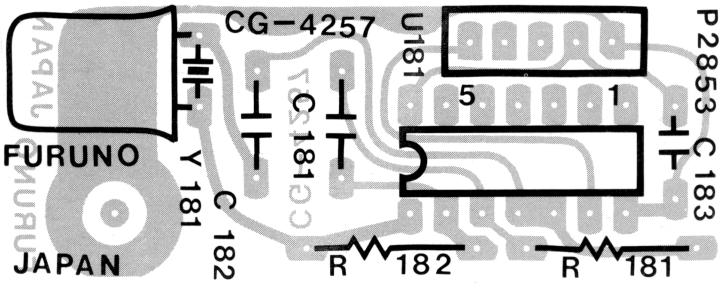


Fig.6-16 CG-4257 8MHz CLOCK PCB (Option)

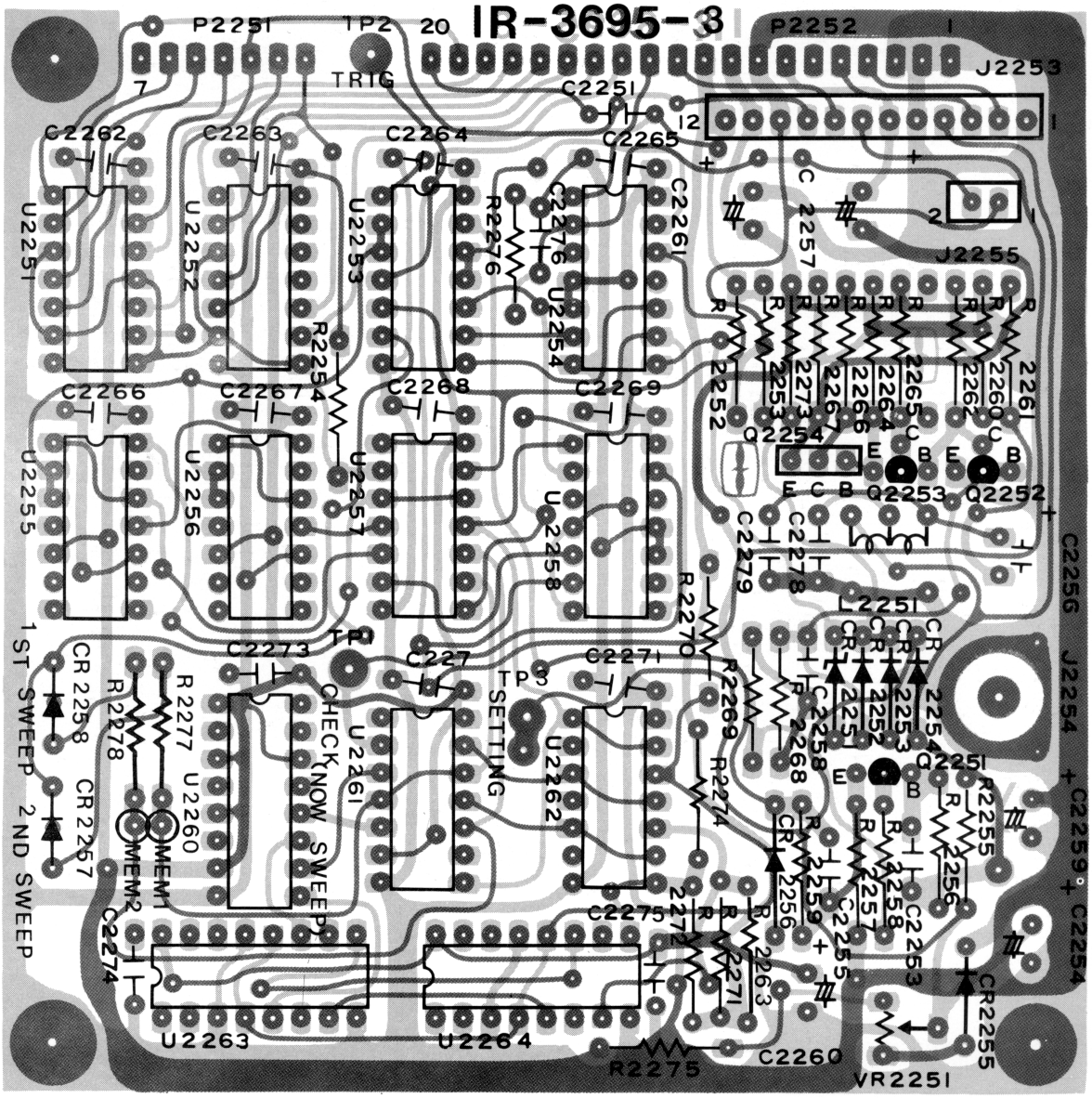


Fig.6-17 IR-3695 INTERFERENCE REJECTOR PCB (Option)

SYMBOL 記号		TYPE 型名	SPECIFICATIONS 規格	CODE NO. コード番号	REMARKS 備考
		PRINTED CIRCUIT BOARD プリントキバン			
		IF-4435 ASSY.	MODEL-1600	003-037-540	IF AMP W/CASE
		MD-4171 ASSY.	MODEL-1600	003-037-550	MODULATOR
		MC-4363 ASSY.	MODEL-1600	003-037-570	MOTOR CONTROL
		MOTOR	モーター		
B	801	OSR-F	13-3-4510	000-432-000	
		CAPACITOR	コンデンサー		
C	601	DD109E103P50V02	0.01UF 50V	000-253-436	
C	607	DD104B102K50V02	1000PF 50V	000-252-171	
C	608	DD104B102K50V02	1000PF 50V	000-252-171	
C	609	ECC-F1H100DC	10PF,50V	000-255-210	
C	610	DD104B102K50V02	1000PF 50V	000-252-171	
C	611	ECQ-M 1H 682KZ	6800PF 50V	000-260-371	
C	612	DD109F103P50V02	0.01UF 50V	000-253-436	
C	615	ECE-F1H220JC2	22PF 50V	000-256-905	
C	617	DD104B102K50V02	1000PF 50V	000-252-171	
C	618	DD104B102K50V02	1000PF 50V	000-252-171	
C	619	DD104B102K50V02	1000PF 50V	000-252-171	
C	621	DD104B102K50V02	1000PF 50V	000-252-171	
C	622	DD104B102K50V02	1000PF 50V	000-252-171	
C	623	DD104B102K50V02	1000PF 50V	000-252-171	
C	624	DD104B102K50V02	1000PF 50V	000-252-171	
C	625	DD104B102K50V02	1000PF 50V	000-252-171	
C	626	DD104B102K50V02	1000PF 50V	000-252-171	
C	627	DD104B102K50V02	1000PF 50V	000-252-171	
C	628	ECC-F1H150JC2	15PF, 50V	000-256-902	
C	629	DD104B102K50V02	1000PF 50V	000-252-171	
C	631	DD104B102K50V02	1000PF 50V	000-252-171	
C	632	DD104B102K50V02	1000PF 50V	000-252-171	
C	633	ECC-F1H150JC2	15PF, 50V	000-256-902	
C	634	DD109E103P50V02	0.01UF 50V	000-253-436	
C	635	DD104B102K50V02	1000PF 50V	000-252-171	
C	636	DD104B102K50V02	1000PF 50V	000-252-171	
C	637	DD104B102K50V02	1000PF 50V	000-252-171	
C	638	DD104B102K50V02	1000PF 50V	000-252-171	
C	639	ECEA1CS101	100UF 16V	000-201-427	
C	640	DD104B102K50V02	1000PF 50V	000-252-171	
C	641	ECEA1CS100	10UF 16V	000-201-423	
C	642	ECEA1CS101	100UF 16V	000-201-427	
C	643	ECQ-M 1H 473KZ	47000PF 50V	000-260-385	
C	644	DD104B102K50V02	1000PF 50V	000-252-171	
C	645	DD104B102K50V02	1000PF 50V	000-252-171	
C	646	DD109E103P50V02	0.01UF 50V	000-253-436	
C	647	DD104B102K50V02	1000PF 50V	000-252-171	
C	648	DD104B102K50V02	1000PF 50V	000-252-171	
C	649	DD104B102K50V02	1000PF 50V	000-252-171	
C	650	ECEA1CS101	100UF 16V	000-201-427	
C	651	DD104B102K50V02	1000PF 50V	000-252-171	
C	652	DD104B102K50V02	1000PF 50V	000-252-171	
C	653	RPE110CH331J50	330PF, 50V	000-251-702	
C	654	ECQ-M 1H 103KZ	0.01UF 50V	000-260-370	
C	655	ECQ-M 1H 103KZ	0.01UF 50V	000-260-370	
C	656	ECQ-M-1H332KZ	3300PF 50WV	000-260-364	
C	657	ECQ-M-1H152KZ	1500PF 50WV	000-260-362	
C	658	ECEA1CS100	10UF 16V	000-201-423	
C	659	DD104B102K50V02	1000PF 50V	000-252-171	
C	660	DD104B102K50V02	1000PF 50V	000-252-171	
C	661	ECEA1CS100	10UF 16V	000-201-423	
C	662	DD104B102K50V02	1000PF 50V	000-252-171	
C	663	ECQ-M 1H 104KZ	0.1UF 50V	000-260-390	
C	664	ECQ-M 1H 334KZ	0.33UF 50V	000-260-389	
C	665	DD109F103P50V02	0.01UF 50V	000-253-436	
C	666	DD104B102K50V02	1000PF 50V	000-252-171	
C	667	DD104B102K50V02	1000PF 50V	000-252-171	
C	668	DD104B102K50V02	1000PF 50V	000-252-171	
C	669	RPE110CH101J50	100PF, 50V	000-251-700	
C	670	DD104B102K50V02	1000PF 50V	000-252-171	
C	671	DD104B102K50V02	1000PF 50V	000-252-171	
C	801	MD-1-2G-334M	0.33UF, 400V	000-202-089	
C	802	ECK-D3A222KB2	2200PF	000-255-750	
C	803	ECW-H06H123JD	0.012UF	000-259-529	
C	804	ECW-H06H223JD	0.022 UF	000-259-532	
C	805	ECW-H06H223JD	0.022 UF	000-259-532	
C	806	ECK-D3A222KB2	2200PF	000-255-750	
C	807	ECQ-M 1H 104KZ	0.1UF 50V	000-260-390	
C	808	ECQ-M 1H 104KZ	0.1UF 50V	000-260-390	
C	809	ECQ-M 1H 104KZ	0.1UF 50V	000-260-390	
C	810	ECQ-M 1H 104KZ	0.1UF 50V	000-260-390	
C	811	ECQ-M 1H 104KZ	0.1UF 50V	000-260-390	
C	812	ECEA1HS010	1UF 50V	000-201-459	
C	821	RPE110CH331J50	330PF, 50V	000-251-702	
C	822	ECQ-M 1H 102KZ	1000PF 50V	000-260-360	
C	823	ECQ-M 1H 102KZ	1000PF 50V	000-260-360	
C	824	CS99E1D6R8M3	6.8UF	000-232-060	
C	825	ECEA1CS101	100UF 16V	000-201-427	
C	826	ECEA1CS101	100UF 16V	000-201-427	
C	831	ECQ-M 1H 103KZ	0.01UF 50V	000-260-370	
C	840	DD104B102K50V02	1000PF 50V	000-252-171	
C	901	ECEA1CS101	100UF 16V	000-201-427	
C	902	DD109E103P50V02	0.01UF 50V	000-253-436	
C	903	ECQ-M 1H 103KZ	0.01UF 50V	000-260-370	
C	904	ECEA1CS100	10UF 16V	000-201-423	
C	931	ECQ-M 1H 103KZ	0.01UF 50V	000-260-370	
C	932	ECQ-M 1H 103KZ	0.01UF 50V	000-260-370	
C	933	ECQ-M 1H 473KZ	47000PF 50V	000-260-385	
C	934	ECEA1ES100	10UF 25V	000-201-436	
C	935	ECEA1CS101	100UF 16V	000-201-427	
C	937	ECEA1CS101	100UF 16V	000-201-427	
		DIODE	ダイオード		
CR	601	1S1588		000-112-795	
CR	602	1S1588		000-112-795	
CR	603	1S1588		000-112-795	
CR	604	1S1588		000-112-795	
CR	605	1S1588		000-112-795	
CR	606	1S1588		000-112-795	
CR	607	0SZ5.1L		000-110-801	
CR	608	1S1588		000-112-795	
CR	609	1S1588		000-112-795	
CR	610	1S1588		000-112-795	
CR	611	RD-6.8FB		000-134-800	
CR	612	RD-22EB		000-134-840	
CR	613	RD-22EB		000-134-840	
CR	801	V11J		000-136-012	
CR	802	V11J		000-136-012	
CR	803	S6080B		000-135-000	
CR	804	SB-2		000-135-012	
CR	805	1S2095A		000-113-046	
CR	806	1S1588		000-112-795	
CR	807	V11J		000-136-012	
CR	810	S-LX5B(S)		000-107-088	
CR	821	1S1588		000-112-795	
CR	931	1S1588		000-112-795	
CR	932	1S1588		000-112-795	
CR	933	RD10EB		000-134-816	
CR	934	V-19E		000-136-020	
		CIRCULATOR	サーキュレータ		
HY	801	RC-4356		000-106-860	
		JACK	ジャック		
J	611	B13P-SHF-1AA		000-505-563	
J	612	B6P-SHF-1AA		000-505-554	
J	613	B6P-SHF-1AA		000-505-554	
J	614	LR-15		000-505-475	
		LLM-01T-2.0		000-505-494	CONTACT 13PCS
J	801	LR-12		000-505-473	
		LLM-01T-2.0		000-505-494	CONTACT 11PCS
J	901	B6P-SHF-1AA		000-505-554	
J	902	B2P-SHF-1AA		000-505-550	
J	931	B3P-SHF-1AA		000-505-551	
		RELAY	リレー		
K	801	HC1-P-DC12V		000-454-521	
		COIL	コイル		
L	605	EL0710-5R6K00S0037	5.6UH 270MA	000-427-625	
L	606	EL0710-5R6K00S0037	5.6UH 270MA	000-427-625	
L	801	RL-3516	13-3-3516	000-733-516	
L	802	RL-4584		000-734-584	
		OR-12.4-6HSB-5		000-421-402	CORE
L	803	RL-3903		000-733-903	
		OR-12.4-6HSB-5		000-421-402	CORE
L	804	RL-4170	12-3-4170	000-734-170	
		PLUG	プラグ		
P	611	H13P-SHF-AA		000-505-610	
		SHF-001T-0.8S		000-505-301	CONTACT 13PCS
P	612	H6P-SHF-AA		000-505-599	
		SHF-001T-0.8S		000-505-301	CONTACT 6PCS
P	613	H6P-SHF-AA		000-505-599	
		SHF-001T-0.8S		000-505-301	CONTACT 6PCS
P	614	LP-15		000-505-461	
		LLF-01T-2.0		000-505-495	CONTACT 13PCS

NOTE:
備考:

SYMBOL 記号		TYPE 型名	SPECIFICATIONS 規格	CODE NO. コード番号	REMARKS 備考
P	801	LP-12		000-505-460	
		LLF-01T-2.0		000-505-495	CONTACT 11PCS
P	901	H6P-SHF-AA		000-505-599	
		SHF-001T-08S		000-505-301	CONTACT 6PCS
P	902	H2P-SHF-AA		000-505-595	
		SHF-001T-08S		000-505-301	CONTACT 2PCS
P	931	H3P-SHF-AA		000-505-596	
		SHF-001T-08S		000-505-301	CONTACT 2PCS
		TRANSISTOR	トランジスター		
Q	601	2SC606 BLUE		000-123-910	
Q	602	2SC606 BLUE		000-123-910	
Q	603	2SC372GTM-Y		000-123-561	
Q	604	2SA495GTM-Y		000-116-993	
Q	605	2SC372GTM-Y		000-123-561	
Q	606	2SC372GTM-Y		000-123-561	
Q	607	2SC372GTM-Y		000-123-561	
Q	608	2SC372GTM-Y		000-123-561	
Q	609	2SA495GTM-Y		000-116-993	
Q	821	2SC752GTM-O		000-124-129	
Q	822	2SA715C		000-117-430	
Q	831	2SC945		000-124-420	
Q	901	2SA495GTM-O		000-116-992	
Q	902	2SC367GTM-O		000-123-552	
Q	931	2SA495GTM-O		000-116-992	
Q	932	2SC945		000-124-420	
Q	933	2SB595-0		000-121-103	
		RESISTOR	テイコウ		
R	603	ERD-25TJ101	0.25W 100	000-330-333	
R	604	ERD-25TJ561	0.25W 560	000-330-351	
R	605	ERD-25TJ392	0.25W 3.9K	000-330-371	
R	606	ERD-25TJ472	0.25W 4.7K	000-330-373	
R	608	ERD-25TJ272	0.25W 2.7K	000-330-367	
R	609	ERD-25TJ331	0.25W 330	000-330-345	
R	610	ERD-25TJ102	0.25W 1K	000-330-357	
R	611	ERD-25TJ181	0.25W 180	000-330-339	
R	612	ERD-25TJ102	0.25W 1K	000-330-357	
R	613	ERD-25TJ821	0.25W 820	000-330-355	
R	614	ERD-25TJ332	0.25W 3.3K	000-330-369	
R	615	ERD-25TJ391	0.25W 390	000-330-347	
R	616	ERD-25TJ152	0.25W 1.5K	000-330-361	
R	617	ERD-25TJ331	0.25W 330	000-330-345	
R	618	ERD-25TJ221	0.25W 220	000-330-341	
R	619	ERD-25TJ471	0.25W 470	000-330-349	
R	620	ERD-25TJ100	0.25W 10	000-330-309	
R	621	ERD-25TJ100	0.25W 10	000-330-309	
R	622	ERD-25TJ100	0.25W 10	000-330-309	
R	623	ERD-25TJ220	0.25W 22	000-330-317	
R	624	ERD-25TJ222	0.25W 2.2K	000-330-365	
R	625	ERD-25TJ222	0.25W 2.2K	000-330-365	
R	626	ERD-25TJ105	0.25W 1M	000-330-429	
R	627	ERD-25TJ102	0.25W 1K	000-330-357	
R	628	ERD-25TJ223	0.25W 22K	000-330-389	
R	629	ERD-25TJ222	0.25W 2.2K	000-330-365	
R	630	ERD-25TJ101	0.25W 100	000-330-333	
R	631	ERD-25TJ102	0.25W 1K	000-330-357	
R	632	ERD-25TJ102	0.25W 1K	000-330-357	
R	633	ERD-25TJ682	0.25W 6.8K	000-330-377	
R	634	ERD-25TJ473	0.25W 47K	000-330-397	
R	635	ERD-25TJ103	0.25W 10K	000-330-381	
R	636	ERD-25TJ223	0.25W 22K	000-330-389	
R	637	ERD-25TJ103	0.25W 10K	000-330-381	
R	638	ERD-25TJ102	0.25W 1K	000-330-357	
R	639	ERD-25TJ562	0.25W 5.6K	000-330-375	
R	640	ERD-25TJ103	0.25W 10K	000-330-381	
R	641	ERD-25TJ332	0.25W 3.3K	000-330-369	
R	642	ERD-25TJ102	0.25W 1K	000-330-357	
R	643	ERD-25TJ100	0.25W 10	000-330-309	
R	645	ERD-25TJ104	0.25W 100K	000-330-405	
R	646	ERD-25TJ271	0.25W 270	000-330-343	
R	647	ERD-25TJ331	0.25W 330	000-330-345	
R	648	ERD-25TJ100	0.25W 10	000-330-309	
R	649	ERG-1ANJ390	1W 39	000-371-227	
R	650	ERD-25TJ823	0.25W 82K	000-330-403	
R	651	ERD-25TJ100	0.25W 10	000-330-309	
R	652	ERD-25TJ102	0.25W 1K	000-330-357	
R	653	ERD-25TJ104	0.25W 100K	000-330-405	
R	654	ERD-25TJ181	0.25W 180	000-330-339	
R	655	ERD-25TJ103	0.25W 10K	000-330-381	
R	801	ERG-1ANJ220	1W 22	000-371-225	
R	802	ERG-1ANJ220	1W 22	000-371-225	
R	803	ERX-2ANJ3R9	2W 3.9	000-371-163	
R	804	ERX-1ANJ5R1	1W 5.1	000-371-072	
R	805	ERX-1ANJ1R0	1W 1	000-371-055	
R	806	ERD-25TJ102	0.25W 1K	000-330-357	
R	807	ERX-1ANJR62	1W 0.62	000-371-050	

SYMBOL 記号		TYPE 型名	SPECIFICATIONS 規格	CODE NO. コード番号	REMARKS 備考
R	821	ERG-1ANJ101	1W 100	000-371-240	
R	822	ERD-25TJ102	0.25W 1K	000-330-357	
R	823	ERD-25TJ682	0.25W 6.8K	000-330-377	
R	824	ERD-25TJ102	0.25W 1K	000-330-357	
R	825	ERD-25TJ101	0.25W 100	000-330-333	
R	826	ERD-25TJ100	0.25W 10	000-330-309	
R	827	ERD-25TJ100	0.25W 10	000-330-309	
R	831	ERD-25TJ103	0.25W 10K	000-330-381	
R	832	ERD-25TJ103	0.25W 10K	000-330-381	
R	833	ERD-25TJ473	0.25W 47K	000-330-397	
R	834	ERD-25TJ223	0.25W 22K	000-330-389	
R	844	ERD-25TJ470	0.25W 47	000-330-325	
R	845	ERD-25TJ473	0.25W 47K	000-330-397	
R	901	ERD-25TJ561	0.25W 560	000-330-351	
R	902	ERD-25TJ100	0.25W 10	000-330-309	
R	903	ERD-25TJ222	0.25W 2.2K	000-330-365	
R	904	ERD-25TJ222	0.25W 2.2K	000-330-365	
R	905	ERD-25TJ332	0.25W 3.3K	000-330-369	
R	906	ERD-25TJ333	0.25W 33K	000-330-393	
R	907	ERD-25TJ102	0.25W 1K	000-330-357	
R	908	ERD-25TJ472	0.25W 4.7K	000-330-373	
R	909	ERD-25TJ103	0.25W 10K	000-330-381	
R	910	ERD-25TJ102	0.25W 1K	000-330-357	
R	911	ERD-25TJ391	0.25W 390	000-330-347	
R	912	ERD-25TJ391	0.25W 390	000-330-347	
R	913	ERD-25TJ391	0.25W 390	000-330-347	
R	914	ERD-25TJ391	0.25W 390	000-330-347	
R	915	ERD-25TJ101	0.25W 100	000-330-333	
R	921	ERD-25TJ331	0.25W 330	000-330-345	
R	931	ERD-25TJ103	0.25W 10K	000-330-381	
R	932	ERD-25TJ563	0.25W 56K	000-330-399	
R	933	ERD-25TJ152	0.25W 1.5K	000-330-361	
R	934	ERD-25TJ102	0.25W 1K	000-330-357	
R	935	ERD-25TJ561	0.25W 560	000-330-351	
R	936	ERD-25TJ152	0.25W 1.5K	000-330-361	
R	937	ERD-25TJ102	0.25W 1K	000-330-357	
R	938	ERD-25TJ122	0.25W 1.2K	000-330-359	
R	939	ERD-25TJ223	0.25W 22K	000-330-389	
		THERMISTOR	サーミスター		
RT	601	D-22A		000-180-617	
		SWITCH	スイッチ		
S	801	NRS-109		000-478-020	
		TRANSFORMER	トランス		
T	601	RT-4487-1	12-3-4487-2	000-734-487	
T	602	RT-4488	12-3-4488	000-734-488	
T	603	RT-4489	12-3-4489	000-734-489	
T	604	RT-4490	12-3-4490	000-734-490	
T	605	RT-4490	12-3-4490	000-734-490	
T	801	RT-4484		000-734-484	
		TERMINAL BOARD	タンシバン		
RTB	801	LK-10P W/NO.1-10		000-533-510	
RTB	802	LK-10P W/NO.11-20		000-533-511	
		INTEGRATED CIRCUIT	シュウセキカイロ		
U	601	UPC595C		000-161-060	
U	602	M5186P		000-150-284	
U	603	MC-14538BCP	C MOS	000-170-016	
U	604	TA78L005AP		000-163-606	
U	801	RU-3684	13-3-3684	000-633-684	MIC *1
U	901	ON-1102		000-134-100	
U	902	HA17902P		000-162-082	
U	931	TA-7555P		000-163-007	
		ELECTRON TUBE	デンシカン		
V	801	9M302/E3513	9410MHZ 3KW	000-101-730	
		POTENTIOMETER	ポテンショメーター		
VR	931	RGP102-202	2K	000-316-256	MOTOR SPEED ADJ.

NOTE:
備考: *1. U801 IS SUPPLIED WITH CR810 AS MIC ASSY. (CODE NO. 008-316-440).

SYMBOL 記号	TYPE 型名	SPECIFICATIONS 規格	CODE NO. コード番号	REMARKS 備考
	PRINTED CIRCUIT BOARD プリントキバン			
	PT-4261 ASSY	MODEL-1600	003-114-140	INVERTER
	LP-4263 ASSY		003-113-740	LAMP
	LP-4264 ASSY		003-113-750	2PCS,LAMP
	BP-3774 ASSY		003-113-660	2PCS,BRUSH MOUNTING
	SR-4466 ASSY		003-634-466	SLIP RING
	FP-3798 ASSY		003-113-650	PHOTO INTERRUPTER
	DU-4262 ASSY	MODEL-1600	003-114-120	MAIN BOARD
	MOTOR	モーター		
B 1651	SM40-4806-C	12-3-3966-1	000-431-452	
	CAPACITOR	コンデンサー		
C 1	ECEA1CS101	100UF 16V	000-201-427	
C 2	ECE-A1CF102	1000UF 16V	000-201-620	
C 3	ECF-A1CF471	470UF 16V	000-201-610	
C 5	ECE-A-160V-10U	10UF 160V	000-200-312	
C 6	DD109E103P50V02	0.01UF 50V	000-253-436	
C 7	ECE-A1HF221	220UF 50V	000-201-630	
C 8	ECE-A-160V-1U	1UF 160V	000-200-300	
C 9	ECE-B-450V-3R3	3.3UF 450V	000-202-404	
C 10	ECE-B-450V-1	1UF 450V	000-202-400	
C 11	ECE-A1AF102	1000UF 10V	000-201-640	
C 12	RPE110CH101J50	100PF, 50V	000-251-700	
C 13	MD2-2A-104M	0.1UF 100V	000-262-369	
C 14	MD2-2A-104M	0.1UF 100V	000-262-369	
C 51	ECEA1CS221	220UF 16V	000-201-428	
C 52	ECEA1CS221	220UF 16V	000-201-428	
C 53	DD109E103P50V02	0.01UF 50V	000-253-436	
C 54	ECEA1AS221	220UF 10V	000-201-415	
C 55	MD2-2A-104M	0.1UF 100V	000-262-369	
C 56	MD2-2A-104M	0.1UF 100V	000-262-369	
C 101	EC0-P1102GZ	0.001UF,100WV	000-261-870	
C 102	EC0-P1102GZ	0.001UF,100WV	000-261-870	
C 103	EC0-M 1H 102KZ	1000PF 50V	000-260-360	
C 104	RPE110CH151J50	150PF 50V	000-251-705	
C 105	EC0-M 1H 102KZ	1000PF 50V	000-260-360	
C 106	ECEA1CS101	100UF 16V	000-201-427	
C 107	RPE110CH331J50	330PF, 50V	000-251-702	
C 108	ECE-A-160V-1U	1UF 160V	000-200-300	
C 109	ECE-A-160V-10U	10UF 160V	000-200-312	
C 110	PRE110CH471J50	470PF 50V	000-251-703	
C 111	ECEA1CS100	10UF 16V	000-201-423	
C 112	RPE110CH331J50	330PF, 50V	000-251-702	
C 113	EC0-P1332GZ	3300PF 100V	000-261-879	
C 114	ECEA1CS100	10UF 16V	000-201-423	
C 115	ECEA1CS100	10UF 16V	000-201-423	
C 117	ECEA1CS100	10UF 16V	000-201-423	
C 118	ECE-F1H330JC	33PF 50VDC	000-255-222	
C 119	ECEA1CS101	100UF 16V	000-201-427	
C 120	ECEA1CS101	100UF 16V	000-201-427	
C 121	ECE-F1H220JC2	22PF 50V	000-256-905	
C 122	RPE110CH101J50	100PF, 50V	000-251-700	
C 123	RPE110CH151J50	150PF 50V	000-251-705	
C 124	ECEA1CS100	10UF 16V	000-201-423	
C 125	ECEA1CS100	10UF 16V	000-201-423	
C 126	ECEA1CS330	33UF 16V	000-201-425	
C 127	RPE110CH101J50	100PF, 50V	000-251-700	
C 128	RPE110CH151J50	150PF 50V	000-251-705	
C 129	ECE-T2CR221SL	220UF 160V	000-205-501	
C 130	ECE-F1H030CC	3PF 50VDC	000-255-203	
C 131	ECE-F1H330JC	33PF 50VDC	000-255-222	
C 132	ECC-F1H150JC2	15PF, 50V	000-256-902	
C 136	DD610BC204Z	0.2UF 12WV	000-252-260	
C 137	DD610BC204Z	0.2UF 12WV	000-252-260	
C 138	DD610BC204Z	0.2UF 12WV	000-252-260	
C 139	DD610BC204Z	0.2UF 12WV	000-252-260	
C 140	DD610BC204Z	0.2UF 12WV	000-252-260	
C 141	DD610BC204Z	0.2UF 12WV	000-252-260	
C 142	DD109E103P50V02	0.01UF 50V	000-253-436	
C 143	DD610BC204Z	0.2UF 12WV	000-252-260	
C 145	DD109E103P50V02	0.01UF 50V	000-253-436	
C 201	RPE110CH151J50	150PF 50V	000-251-705	
C 202	ECEA1CS100	10UF 16V	000-201-423	
C 204	ECEA1CS101	100UF 16V	000-201-427	
C 205	ECEA1CS221	220UF 16V	000-201-428	
C 206	ECEA1CS100	10UF 16V	000-201-423	
C 207	EC0-M-1H563KZ	0.056UF 50WV	000-260-379	
C 208	ECEA1HS010	1UF 50V	000-201-459	
C 209	EC0-M 1H 473KZ	47000PF 50V	000-260-385	
C 210	ECF-A-160V-10U	10UF 160V	000-200-312	
C 211	PRE110CH471J50	470PF 50V	000-251-703	
C 212	PRE110CH471J50	470PF 50V	000-251-703	
C 213	MD2-2A-104M	0.1UF 100V	000-262-369	
C 301	ECE-F1H180JC	18PF 50VDC	000-255-216	
C 302	RPE110CH151J50	150PF 50V	000-251-705	
C 401	EC0-M 1H 103KZ	0.01UF 50V	000-260-370	
C 402	ECEA1AS101	100UF 10V	000-201-414	
C 403	DD610BC204Z	0.2UF 12WV	000-252-260	
C 411	ECEA1HS221	220UF 50V	000-201-468	
C 501	MD-2-2G-104M	0.1UF 400WV	000-262-313	
C 502	MD-2-2G-104M	0.1UF 400WV	000-262-313	
C 503	MD-2-2G-224M	0.22UF 400WV	000-262-315	
C 504	MD-2-2G-104M	0.1UF 400WV	000-262-313	
C 505	ECE-A-160V-10U	10UF 160V	000-200-312	
C 1301	MD2-2A-105M	1UF 100V	000-262-371	
C 1302	MD2-2A-105M	1UF 100V	000-262-371	
C 1303	MD2-2A-105M	1UF 100V	000-262-371	
C 1304	FTE1G222	2200UF 40V	000-218-011	
C 1305	ECEB1CS471	470UF 16V	000-203-300	
C 1306	RPE111CH821J50	820PF 50V	000-251-722	
C 1307	ECFA1CS100	10UF 16V	000-201-423	
C 1308	ECEA1AS101	100UF 10V	000-201-414	
C 1309	EC0-M 1H 683KZ	0.068UF 50V	000-260-381	
C 1351	MD2-2A-225M	2.2UF 100V	000-262-370	
C 1352	MD2-2A-225M	2.2UF 100V	000-262-370	
C 1353	MD2-2A-225M	2.2UF 100V	000-262-370	
C 1354	ECK-F1H473ZF	0.047UF 50VDC	000-255-151	
C 1355	ECK-F1H473ZF	0.047UF 50VDC	000-255-151	
C 1601	ECEA1CS101	100UF 16V	000-201-427	
C 1611	DD109E103P50V02	0.01UF 50V	000-253-436	
C 1612	DD109E103P50V02	0.01UF 50V	000-253-436	
C 1613	DD109E103P50V02	0.01UF 50V	000-253-436	
	DIODE	ダイオード		
CR 1	CTU-22S		000-132-446	
CR 2	CTU-22S		000-132-446	
CR 3	CTU-22R		000-132-445	
CR 4	1S2095A		000-113-046	
CR 5	1S2095A		000-113-046	
CR 6	1S1588		000-112-795	
CR 7	1S1588		000-112-795	
CR 8	V-19E		000-136-020	
CR 9	V-19E		000-136-020	
CR 10	RD-30EB		000-134-855	
CR 11	RD-30EB		000-134-855	
CR 12	V-19E		000-136-020	
CR 13	V-19E		000-136-020	
CR 14	V11N		000-136-016	
CR 15	V11N		000-136-016	
CR 16	ERZ15D3K221		000-132-669	
CR 17	CTU-22S		000-132-446	
CR 18	1S1588		000-112-795	
CR 19	1S1588		000-112-795	
CR 20	RD-6.2EB1		000-134-833	
CR 101	1S1588		000-112-795	
CR 102	1S1588		000-112-795	
CR 103	1S1588		000-112-795	
CR 104	1S1588		000-112-795	
CR 105	1S2462		000-113-090	
CR 106	1S1588		000-112-795	
CR 107	RD10EB		000-134-816	
CR 108	05Z5.1L		000-110-801	
CR 109	1S1588		000-112-795	
CR 110	1S1588		000-112-795	
CR 111	1S1588		000-112-795	
CR 112	V-19E		000-136-020	
CR 202	1S1588		000-112-795	
CR 203	1S1588		000-112-795	
CR 204	1S1588		000-112-795	
CR 205	1N60		000-111-090	
CR 206	MA26WO-B		000-133-739	
CR 207	1S2462		000-113-090	
CR 208	1S1588		000-112-795	
CR 209	1S1588		000-112-795	
CR 210	RD-6.2EB1		000-134-833	
CR 301	1S1588		000-112-795	
CR 401	LN35BP		000-133-609	
CR 402	1S1588		000-112-795	
CR 501	1S2462		000-113-090	
CR 502	RD-33EB		000-134-860	
CR 503	RD-33EB		000-134-860	
CR 504	RD-33EB		000-134-860	
CR 505	1S2462		000-113-090	
CR 1301	U06C		000-135-901	
CR 1302	1S1588		000-112-795	
CR 1303	1S1588		000-112-795	
CR 1304	RD-9.1EB1		000-134-835	
CR 1305	MA26WO-B		000-133-739	
CR 1601	1S1588		000-112-795	
	CONNECTOR	コネクター		
DJ 1	MCP-24F02		000-500-161	HOUSING
	MCP-24S		000-500-164	FIXTURE
	MCP-F102R		000-500-163	CONTACT 20PCS

NOTE:
備考:

SYMBOL 記号		TYPE 型名	SPECIFICATIONS 規格	CODE NO. コード番号	REMARKS 備考
		CONNECTOR	コネクタ		
DP	1	MCP-24M02		000-500-160	HOUSING
		MCP-24WS2		000-500-150	FIXTURE
		MCP-M102R		000-500-162	CONTACT 20PCS
		LAMP	ランプ		
DS	51	T3.8C-8V-60MA	13-3-4442	000-540-180	
DS	52	T3.8C-8V-60MA	13-3-4442	000-540-180	
DS	53	T3.8C-8V-60MA	13-3-4442	000-540-180	
DS	54	T3.8C-8V-60MA	13-3-4442	000-540-180	
		CARBON BRUSH	カーボン ブラシ		
E	181	12-3-3249-2		000-633-249	
E	182	12-3-3249-2		000-633-249	
		FUSE	ヒューズ		
F	1	F-1065, 0.5A	6.4MM DIA	000-547-004	
F	2	F-7161, 5A	6.4MM DIA	000-547-012	
F	1351	F-7161, 10A	6.4MM DIA	000-547-015	
F	1352	F-7161, 1A	6.4MM DIA	000-547-006	
		HIGH VOLTAGE PACK	コウアツパック		
HY	551	RU-3679-2		000-633-678	
		JACK	ジャック		
J	1	BS6P-SHF-1AA		000-505-569	
J	2	BS15P-SHF-1AA	15P	000-505-576	
J	3	BS2P-SHF-1AA		000-505-565	
J	51	B6P-SHF-1AA		000-505-554	
J	52	B15P-SHF-1AA		000-505-561	
J	53	B2P-SHF-1AA		000-505-550	
J	54	B4P-SHF-1AA		000-505-552	
J	55	B2P-SHF-1AA		000-505-550	
J	56	B3P-SHF-1AA		000-505-551	
J	57	B3P-SHF-1AA		000-505-551	
J	58	B4P-SHF-1AA		000-505-552	
J	59	B10P-SHF-1AA		000-505-558	
J	60	B9P-SHF-1AA		000-505-557	
J	151	B4P-SHF-1AA		000-505-552	
J	201	CN-3561 1P (F)		000-510-559	
J	501	RT-01T-1.3B		000-505-352	
J	502	B3P-SHF-1AA		000-505-551	
J	503	B7P-SHF-1AA		000-505-555	
J	505	SMR-03V-B		000-505-370	
		SYM-001T-0.6		000-505-360	CONTACT 1PC
J	1301	RTB-1.5-4F		000-505-351	
J	1351	16R-2A, 2P (M) ROUND FOR 16P-2B		000-500-347	
J	1651	B6P-SHF-1AA		000-505-554	
J	1652	B3P-SHF-1AA		000-505-551	
J	2251	F7P-HVQ		000-505-407	
J	2252	F20P-HVQ		000-505-420	
J	2256	B2P-SHF-1AA		000-505-550	
J	2852	F9P-HVQ		000-505-409	
J	2853	F5P-SHVQ		000-505-429	
		RELAY	リレー		
K	1	MR31-12		000-454-079	
K	2	MR31-12		000-454-079	
K	201	RRS51A12		000-455-198	
		COIL	コイル		
L	1	RL-4157	330UH	000-734-157	
L	2	RL-3980	265UH	000-733-980	
L	3	RL-4157	330UH	000-734-157	
L	101	RL-3214	12-3-3214	000-733-214	
L	102	EL0710-360K00S0037	36UH 205MA	000-427-630	
L	181	RL-4485		000-734-485	
L	1301	SC-05-100	1MH 5A	000-424-972	

SYMBOL 記号		TYPE 型名	SPECIFICATIONS 規格	CODE NO. コード番号	REMARKS 備考
		PLUG	プラグ		
P	1	H6P-SHF-AA		000-505-599	
		SHF-001T-08S		000-505-301	CONTACT 6PCS
P	2	H15P-SHF-AA		000-505-606	
		SHF-001T-08S		000-505-301	CONTACT 13PCS
P	3	H2P-SHF-AA		000-505-595	
		SHF-001T-08S		000-505-301	CONTACT 2PCS
P	51	H6P-SHF-AA		000-505-599	
		SHF-001T-08S		000-505-301	CONTACT 6PCS
P	52	H15P-SHF-AA		000-505-606	
		SHF-001T-08S		000-505-301	CONTACT 12PCS
P	53	H2P-SHF-AA		000-505-595	
		SHF-001T-08S		000-505-301	CONTACT 2PCS
P	54	H4P-SHF-AA		000-505-597	
		SHF-001T-08S		000-505-301	CONTACT 4PCS
P	55	H2P-SHF-AA		000-505-595	
		SHF-001T-08S		000-505-301	CONTACT 2PCS
P	56	H3P-SHF-AA		000-505-596	
		SHF-001T-08S		000-505-301	CONTACT 2PCS
P	57	H3P-SHF-AA		000-505-596	
		SHF-001T-08S		000-505-301	CONTACT 3PCS
P	58	H4P-SHF-AA		000-505-597	
		SHF-001T-08S		000-505-301	CONTACT 2PCS
P	59	H10P-SHF-AA		000-505-603	
		SHF-001T-08S		000-505-301	CONTACT 8PCS
P	60	H9P-SHF-AA		000-505-602	
		SHF-001T-08S		000-505-301	CONTACT 9PCS
P	151	H4P-SHF-AA		000-505-597	
		SHF-001T-08S		000-505-301	CONTACT 2PCS
P	201	CN-7042 BLK		000-510-580	
P	501	LDF-01T-1.3A		000-538-140	
P	503	H7P-SHF-AA		000-505-600	
		SHF-001T-08S		000-505-301	CONTACT 5PCS
P	504	S8-502B-30		000-510-105	CRT SOCKET
P	505	SMP-03V-B		000-505-375	
		SHF-001T-08S		000-505-301	CONTACT 1PC
P	1301	S4P-SVF		000-505-520	
		SVF-01T-1.5N		000-505-379	CONTACT 4PCS
P	1651	H6P-SHF-AA		000-505-599	
		SHF-001T-08S		000-505-301	CONTACT 6PCS
P	1652	H3P-SHF-AA		000-505-596	
		SHF-001T-08S		000-505-301	CONTACT 3PCS
		TRANSISTOR	トランジスター		
Q	1	2SC945		000-124-420	
Q	2	2SA495GTM-O		000-116-992	
Q	3	2SA495GTM-O		000-116-992	
Q	4	2SC2334(6)K		000-126-152	
Q	5	2SC2334(6)K		000-126-152	
Q	6	2SC945		000-124-420	
Q	7	2SC945		000-124-420	
Q	101	2SC367GTM-O		000-123-552	
Q	102	2SA467GTM-O		000-116-930	
Q	103	2SA778-K		000-117-520	
Q	104	2SA467GTM-O		000-116-930	
Q	105	2SC367GTM-O		000-123-552	
Q	106	2SC2837-O		000-126-301	
Q	107	2SC367GTM-O		000-123-552	
Q	108	2SC367GTM-O		000-123-552	
Q	201	2SC1569		000-125-117	
Q	401	2SA733		000-117-445	
Q	1301	2SB434Y		000-120-871	
Q	1302	2SA467GTM-O		000-116-930	
Q	1303	2SA467GTM-O		000-116-930	
Q	1304	2SC2334(6)K		000-126-152	
Q	1305	2SC2334(6)K		000-126-152	

NOTE:
備考:

SYMBOL 記号	TYPE 型名	SPECIFICATIONS 規格	CODE NO. コード番号	REMARKS 備考
	RESISTOR	ﾃｲｺｳ		
R 1	ERD-25TJ101	0.25W 100	000-330-333	
R 3	ERD-25TJ821	0.25W 820	000-330-355	
R 4	ERD-25TJ102	0.25W 1K	000-330-357	
R 5	ERD-25TJ183	0.25W 18K	000-330-387	
R 6	ERD-25TJ222	0.25W 2.2K	000-330-365	
R 7	ERD-25TJ101	0.25W 100	000-330-333	
R 8	ERD-25TJ101	0.25W 100	000-330-333	
R 9	ERD-25TJ220	0.25W 22	000-330-317	
R 10	ERD-25TJ220	0.25W 22	000-330-317	
R 11	ERG-1ANJ330	1W 33	000-371-226	
R 12	ERG-1ANJ 100	1W 10	000-371-218	
R 13	ERX-1ANJ2R2	1W 2.2	000-371-063	
R 14	ERG-1ANJ153	1W 15K	000-371-309	
R 15	ERD-12TJ124	0.5W 120K	000-330-107	
R 16	ERD-12TJ124	0.5W 120K	000-330-107	
R 17	ERD-25TJ473	0.25W 47K	000-330-397	
R 101	ERD-25TJ222	0.25W 2.2K	000-330-365	
R 102	ERD-25TJ472	0.25W 4.7K	000-330-373	
R 103	EXBP88822K	8.2K X 8	000-378-509	
R 104	ERD-25TJ102	0.25W 1K	000-330-357	
R 105	ERD-25TJ152	0.25W 1.5K	000-330-361	
R 106	ERD-25TJ102	0.25W 1K	000-330-357	
R 107	ERD-25TJ821	0.25W 820	000-330-355	
R 108	ERD-25TJ152	0.25W 1.5K	000-330-361	
R 109	ERD-25TJ331	0.25W 330	000-330-345	
R 110	ERD-25TJ680	0.25W 68	000-330-329	
R 111	ERD-25TJ102	0.25W 1K	000-330-357	
R 112	ERD-25TJ330	0.25W 33	000-330-321	
R 113	ERD-25TJ223	0.25W 22K	000-330-389	
R 114	ERD-25TJ222	0.25W 2.2K	000-330-365	
R 115	ERD-25TJ223	0.25W 22K	000-330-389	
R 116	ERD-25TJ103	0.25W 10K	000-330-381	
R 117	ERG-1ANJ822	1W 8.2K	000-371-299	
R 118	ERD-25TJ332	0.25W 3.3K	000-330-369	
R 119	ERD-25TJ121	0.25W 120	000-330-335	
R 120	ERD-25TJ561	0.25W 560	000-330-351	
R 121	ERD-25TJ101	0.25W 100	000-330-333	
R 122	ERD-25TJ471	0.25W 470	000-330-349	
R 123	RC-4233		000-378-102	
R 124	ERD-25TJ220	0.25W 22	000-330-317	
R 125	ERD-25TJ682	0.25W 6.8K	000-330-377	
R 126	ERD-25TJ102	0.25W 1K	000-330-357	
R 127	ERD-25TJ562	0.25W 5.6K	000-330-375	
R 128	ERD-25TJ104	0.25W 100K	000-330-405	
R 129	ERD-25TJ392	0.25W 3.9K	000-330-371	
R 130	ERD-25TJ562	0.25W 5.6K	000-330-375	
R 131	ERD-25TJ221	0.25W 220	000-330-341	
R 132	ERD-25TJ221	0.25W 220	000-330-341	
R 133	ERD-25TJ474	0.25W 470K	000-330-421	
R 134	RED-25TJ154	0.25W 150K	000-330-409	
R 135	ERD-25TJ224	0.25W 220K	000-330-413	
R 136	ERD-25TJ822	0.25W 8.2K	000-330-379	
R 137	ERD-25TJ392	0.25W 3.9K	000-330-371	
R 138	ERG-2ANJ820	2W 82	000-371-346	
R 139	ERD-25TJ102	0.25W 1K	000-330-357	
R 140	ERD-25TJ473	0.25W 47K	000-330-397	
R 141	ERX-2ANJ3R9	2W 3.9	000-371-163	
R 142	ERX-1ANJR51	1W 0.51	000-371-048	
R 143	ERD-25TJ680	0.25W 68	000-330-329	
R 144	ERD-25TJ153	0.25W 15K	000-330-385	
R 145	ERG-1ANJ471	1W 470	000-371-256	
R 146	ERD-25TJ333	0.25W 33K	000-330-393	
R 147	ERD-25TJ472	0.25W 4.7K	000-330-373	
R 148	ERD-25TJ332	0.25W 3.3K	000-330-369	
R 149	ERD-25TJ332	0.25W 3.3K	000-330-369	
R 150	ERD-25TJ152	0.25W 1.5K	000-330-361	
R 152	ERD-25TJ332	0.25W 3.3K	000-330-369	
R 201	ERD-25TJ750	0.25W 75	000-330-330	
R 204	ERD-25TJ182	0.25W 1.8K	000-330-363	
R 205	ERD-25TJ100	0.25W 10	000-330-309	
R 206	ERD-25TJ821	0.25W 820	000-330-355	
R 207	ERD-25TJ103	0.25W 10K	000-330-381	
R 208	ERD-25TJ332	0.25W 3.3K	000-330-369	
R 209	ERD-25TJ472	0.25W 4.7K	000-330-373	
R 210	ERD-25TJ100	0.25W 10	000-330-309	
R 211	ERD-25TJ820	0.25W 82	000-330-331	
R 212	ERD-25TJ222	0.25W 2.2K	000-330-365	
R 213	ERD-25TJ222	0.25W 2.2K	000-330-365	
R 214	ERD-25TJ101	0.25W 100	000-330-333	
R 215	ERD-25TJ564	0.25W 560K	000-330-423	
R 216	ERD-25TJ101	0.25W 100	000-330-333	
R 217	ERD-25TJ272	0.25W 2.7K	000-330-367	
R 219	ERD-25TJ103	0.25W 10K	000-330-381	
R 221	ERD-25TJ121	0.25W 120	000-330-335	
R 222	ERD-25TJ271	0.25W 270	000-330-343	
R 223	ERD-25TJ182	0.25W 1.8K	000-330-363	
R 224	ERD-25TJ821	0.25W 820	000-330-355	
R 225	ERD-25TJ102	0.25W 1K	000-330-357	
R 301	ERD-25TJ472	0.25W 4.7K	000-330-373	
R 302	ERD-25TJ471	0.25W 470	000-330-349	
R 303	ERD-25TJ103	0.25W 10K	000-330-381	
R 401	ERD-25TJ224	0.25W 220K	000-330-413	
R 402	ERD-25TJ474	0.25W 470K	000-330-421	
R 403	ERD-25TJ103	0.25W 10K	000-330-381	
R 404	ERD-25TJ331	0.25W 330	000-330-345	
R 405	ERD-25TJ103	0.25W 10K	000-330-381	
R 406	ERD-25TJ471	0.25W 470	000-330-349	
R 407	ERD-25TJ103	0.25W 10K	000-330-381	
R 408	ERD-25TJ272	0.25W 2.7K	000-330-367	
R 409	ERX-1ANJ3R3	1W 3.3	000-371-067	
R 410	ERD-25TJ102	0.25W 1K	000-330-357	
R 411	ERD-25TJ332	0.25W 3.3K	000-330-369	
R 501	ERD-25TJ104	0.25W 100K	000-330-405	
R 502	ERD-25TJ274	0.25W 270K	000-330-415	
R 503	ERD-25TJ222	0.25W 2.2K	000-330-365	
R 504	RED-25TJ154	0.25W 150K	000-330-409	
R 1301	ERD-25TJ101	0.25W 100	000-330-333	
R 1302	ERD-25TJ101	0.25W 100	000-330-333	
R 1303	ERX-1ANJ4R7	1W 4.7	000-371-071	
R 1304	ERX-1ANJ4R7	1W 4.7	000-371-071	
R 1305	ERD-25TJ470	0.25W 47	000-330-325	
R 1306	ERD-25TJ470	0.25W 47	000-330-325	
R 1308	ERD-25TJ271	0.25W 270	000-330-343	
R 1309	ERD-25TJ332	0.25W 3.3K	000-330-369	
R 1601	ERD-25TJ680	0.25W 68	000-330-329	
R 1602	ERD-25TJ681	0.25W 680	000-330-353	
	SWITCH	ｽｲｯﾁ		
S 101	RR-4266-1		000-634-266	
S 201				HD FL OFF SEE VR51
S 301				RANGE RING SEE VR401
S 401	RR-4265-1		000-634-265	
S 2201				INTRF.REJ. SEE VR601
	TRANSFORMER	ﾄﾗﾝｽ		
T 1	RT-4212		000-734-212	
T 2	RT-4213		000-734-213	
T 1301	RT-4098		000-734-098	
T 1302	RT-4098		000-734-098	
	TEST POINT	ﾃｽﾄﾎﾟｲﾝﾄ		
TP 1	BE12P-SHF-1AA	12P	000-505-590	
	H12P-SHF-AA		000-505-605	HOUSING
	LHF-001T-0.8SS		000-505-493	CONTACT 2PCS
TP 2	RT-01T-1.3R		000-505-352	
TP 3	RT-01T-1.3R		000-505-352	
TP 101	RT-01T-1.3R		000-505-352	
TP 102	RT-01T-1.3R		000-505-352	
TP 103	RT-01T-1.3R		000-505-352	
TP 104	RT-01T-1.3R		000-505-352	
TP 105	RT-01T-1.3R		000-505-352	
TP 106	RT-01T-1.3R		000-505-352	
TP 107	RT-01T-1.3R		000-505-352	
TP 108	RT-01T-1.3R		000-505-352	
TP 201	RT-01T-1.3R		000-505-352	
TP 202	RT-01T-1.3R		000-505-352	
TP 301	RT-01T-1.3R		000-505-352	
TP 401	RT-01T-1.3R		000-505-352	
TP 402	B3P-SHF-1AA		000-505-551	
TP 1301	BE6P-SHF-1AA		000-505-584	
	H6P-SHF-AA		000-505-599	HOUSING
	LHF-001T-0.8SS		000-505-493	CONTACT 2PCS
TP 1302	RT-01T-1.3R		000-505-352	
TP 1303	BE5P-SHF-1AA		000-505-583	
	H5P-SHF-AA		000-505-598	HOUSING
	LHF-001T-0.8SS		000-505-493	CONTACT 2PCS
	INTEGRATED CIRCUIT	ｼｭｳｾｷｶｲﾛ		
U 1	TLP-503-0		000-135-785	
U 2	MC-1453R6CP	C MOS	000-170-016	
U 3	RC-4208		000-378-101	
U 4	RC-4208		000-378-101	
U 101	M74LS148P		000-151-218	
U 102	HD74LS04P		000-162-404	
U 103	M74LS393P		000-151-220	
U 104	HD74LS151P		000-162-510	
U 105	HD74LS161P		000-162-516	
U 106	M74LS221P		000-151-219	
U 107	HD74LS161P		000-162-516	
U 108	HD74LS11P		000-162-411	
U 109	HD74LS26P		000-162-426	
U 110	HD74LS27P		000-162-427	
U 111	MC14541BCP		000-170-018	
U 112	HD74LS132P		000-162-485	
U 113	HD74LS04P		000-162-404	
U 114	HD74LS12P		000-162-412	
U 115	TC-4051BF	CMOS	000-163-257	

NOTE:
備考:

SYMBOL 記号	TYPE 型名	SPECIFICATIONS 規格	CODE NO. コード番号	REMARKS 備考
U 116	TL081CP		000-168-486	
U 117	UPC-157C	LINEAR	000-161-031	
U 201	RC-4232-2		000-164-256	
U 1301	MB3759M		000-157-500	
U 1302	RC-4210-1		000-164-253	
U 1303	RC-4214-1	HYBRID	000-378-100	
U 1601	TC-4011BP	CMOS	000-163-245	
U 1602	TC-4011BP	CMOS	000-163-245	
U 1603	TC-4027BP	CMOS	000-163-251	
U 1604	TD-62004P		000-163-091	
U 1605	RC-4211		000-164-254	
U 1651	ON1105		000-134-102	
	ELECTRON TUBE	ﾃﾞﾝｼｶﾝ		
V 551	180SB7		000-103-600	
	POTENTIOMETER	ﾎﾟﾃﾝｼｮﾒｰﾀｰ		
VR 1	RGP102-501 13-3-3253	500	000-316-250	VOLT.ADJ.
VR 51	RV-4270-1	100	000-319-059	DIMMER VR W/S201
VR 101	RGP102-103	10K	000-316-260	SWEEP TIMING
VR 102	RGP102-103	10K	000-316-260	SWEEP VELOCITY
VR 103	RGP102-104	100K	000-316-265	THRESHOLD
VR 201	RGP102-202	2K	000-316-256	LIMITER
VR 301	RGP102-103	10K	000-316-260	RANGE RING TIMING
VR 401	RV-4267-1	2K, 50K	000-319-057	TUNING & BRILLIANCE DUAL VR W/S301
VR 402	RV-4269	20KX2	000-319-062	TUNING PRESET
VR 501	EVMR0GS20B17	10M	000-307-750	FOCUS
VR 502	RGP102-503	50K	000-316-261	BRILL. PRESET
VR 503	RGP102-204	0.5W 200K	000-316-267	BRILL. PRESET
VR 601	RV-4268-1	2K, 5K	000-319-058	GAIN & STC DUAL VR W/S2201
VR 1301	RGP102-502	5K	000-316-259	FREQ.ADJ.
	FUSE HOLDER	ﾋｭｰｽﾞ ﾎﾙﾀﾞｰ		
XF 1	FH001	6.4MM X 30MM	000-519-180	
XF 2	S-N5051		000-509-056	2PCS
XF 1351	FH001	6.4MM X 30MM	000-519-180	
XF 1352	FH001	6.4MM X 30MM	000-519-180	
	CRYSTAL	ｸﾘｽﾀﾙ		
Y 101	CSA2.59MA1		000-491-030	

SYMBOL 記号	TYPE 型名	SPECIFICATIONS 規格	CODE NO. コード番号	REMARKS 備考

NOTE:
備考:

SYMBOL 記号	PARTS NAME 部品名	TYPE/DWG. NO. 型名/図番	CODE NO. コード番号	REMARKS 備考
A 101	BALANCER HOUSING	03-001-4014-1	300-140-141	
A 102	BALANCER	03-001-4008-2	300-140-082	
A 103	DRAIN TUBE	03-003-3001-0	300-330-010	
A 110A	SCANNER UNIT ASSEMBLY	C1P9N2N9D1-U	003-037-580	FOR USA
A 110A	SCANNER UNIT ASSEMBLY	C1P9N2N9D1-S	003-037-590	FOR OTHER THAN USA.
A 111	SHIELD CASE	03-003-3236-2	300-332-362	
A 120A	RADOME UPPER ASSEMBLY	C1P9N2N M-1600	003-037-600	
A 121	RADOME	C1P9N2N	003-037-660	
A 122	RADOME FIXTURE *1*	03-003-3102-1	300-331-021	
A 123	FURUNO LABEL	03-003-3103-0	300-331-030	
A 130A	RADIATOR ASSEMBLY	XN9	003-037-610	
A 131				NOT SUPPLIED
A 132	MAGNET	RP-1757 MS4X9X15	000-499-055	
A 133	MAGNET MOUNTING PLATE	03-001-4021-2	300-140-212	
A 134	STOPPER	03-001-4013-4	300-140-134	
A 140A	RADOME LOWER ASSEMBLY	C1P9N2N M-1600	003-037-490	
A 141	FLAT WASHER	JIS F8801 A25A BRASS	000-870-205	
A 142	FLAT WASHER	JIS F8801 A25A BRASS	000-870-205	
A 143	RUBBER PACKING	JIS F8801 25A RUBBER	000-870-223	
A 144	CLAMPING PLATE	03-002-3222-0	300-232-220	
A 145	SCANNER LOWER HOUSING	C1P9N2N	003-037-640	
A 146	RADOME FIXTURE *2*	03-003-3202-1	300-332-021	
A 147	FIXING BOLT	03-003-3203-1	300-332-031	
A 148	PACKING FOR DOME	03-003-3204-2	300-332-042	
A 149	SEAL	03-003-3211-0	300-332-110	
A 150	RF ASSY. FIXTURE	03-003-3207-2	300-332-072	
A 151	NUT SOLDERED PLATE	03-003-3208-1	300-332-081	
A 152	RUBBER BLIND	03-003-3209-0	300-332-090	
A 160A	SCANNER DRIVING ASSEMBLY	C1P9N2N M-1600	003-037-480	
A 161	TIMING BELT	150 X L037G	000-841-127	
A 162	BEARING	6006ZZ PS2	000-873-233	
A 163	BEARING	6006ZZ PS2	000-873-233	
A 164	REED SWITCH FIXING PLATE	03-003-3252-1	300-332-521	
A 165	PEDESTAL	03-003-3301-2	300-333-012	
A 166	ADAPTOR *2*	03-003-3302-0	300-333-020	
A 167	MOTOR FIXING PLATE	03-003-3231-2	300-332-312	
A 168	TIMING DISK W/DRIVE GEAR	03-003-3232-1	300-332-321	
A 169	SPACER	03-003-3237-0	300-332-370	
A 170	SCANNER DRIVING PEDESTAL	03-003-3308-1	300-333-081	
A 171	IDLE PULLEY	03-003-3309-0	300-333-090	
A 172	PULLEY FIXING DISK	03-003-3311-1	300-333-111	
A 173	BEARING COLLAR	03-003-3312-0	300-333-120	
A 174	BEARING NUT	03-003-3313-0	300-333-130	
A 175	ADAPTOR WAVEGUIDE	C1P9N2N	003-037-290	
A 190A	RF TRANSCEIVER ASSEMBLY	C1P9N2N M-1600	003-037-510	
A 191	SHIELD CASE COVER *1*	03-004-5304-2	300-453-042	
A 192	SHIELD CASE COVER *1*	03-004-5304-2	300-453-042	
A 193	RF CHASSIS	03-004-5311-1	300-453-111	
A 194	ADAPTOR *1*	03-004-5306-0	300-453-060	
BT 101	HEXAGONAL HEAD BOLT	M4 X 12	000-862-177	8PCS
BT 102	HEXAGONAL HEAD BOLT	M4 X 10	000-862-110	
BT 103	HEXAGONAL HEAD BOLT	M4 X 10	000-862-110	2PCS
BT 104	HEXAGONAL HEAD BOLT	M5 X 25	000-862-125	4PCS
BT 105	HEXAGONAL HEAD BOLT	M6 X 25	000-862-180	8PCS
BT 106	HEXAGONAL HEAD BOLT	M8 X 20	000-862-147	4PCS
BT 107	HEXAGONAL HEAD BOLT	M8 X 16	000-862-350	2PCS
BT 108	HEXAGONAL HEAD BOLT	M12 X 60	000-862-191	4PCS
BT 109	HEXAGONAL HEAD BOLT	M4 X 12	000-862-177	4PCS
BT 110	HEXAGONAL HEAD BOLT	M6 X 12	000-862-127	2PCS
BT 111	HEXAGONAL HEAD BOLT	M4 X 25	000-868-784	4PCS
BT 112	HEXAGONAL HEAD BOLT	M4 X 16	000-862-179	2PCS
BT 113	HEXAGONAL HEAD BOLT	M4 X 22	000-862-142	2PCS
N 101	HEXAGONAL NUT	M6	000-863-109	3PCS

NOTE:

備考:

SYMBOL 記号	PARTS NAME 部品名	TYPE/DWG. NO. 型名/図番	CODE NO. コード番号	REMARKS 備考
S 101	WASHER HEAD SCREW *B*	M4 X 10	000-881-446	2PCS
S 102	WASHER HEAD SCREW *B*	M4 X 10	000-881-446	3PCS
S 103	WASHER HEAD SCREW *A*	M4 X 8	000-881-144	4PCS
S 104	WASHER HEAD SCREW *B*	M4 X 10	000-881-446	2PCS
S 105	WASHER HEAD SCREW *A*	M3 X 10	000-881-105	
S 106	WASHER HEAD SCREW *B*	M4 X 10	000-881-446	3PCS
S 107	WASHER HEAD SCREW *A*	M3 X 6	000-881-103	4PCS
S 108	WASHER HEAD SCREW *A*	M3 X 15	000-881-107	2PCS
S 109	PAN HEAD SCREW	M3 X 15	000-861-117	2PCS
S 110	WASHER HEAD SCREW *A*	M3 X 8	000-881-104	2PCS
S 111	PAN HEAD SCREW	M4 X 60	000-861-025	4PCS
S 112	WASHER HEAD SCREW *A*	M3 X 8	000-881-104	2PCS
S 113	WASHER HEAD SCREW *A*	M4 X 10	000-881-145	3PCS
S 114	WASHER HEAD SCREW *B*	M3 X 12	000-881-406	2PCS
S 115	SOCKET SET SCREW	M4 X 5	000-861-607	
S 116	SOCKET SET SCREW	M4 X 5	000-861-607	
S 117	WASHER HEAD SCREW *B*	M4 X 12	000-881-447	2PCS
S 118	WASHER HEAD SCREW *B*	M4 X 8	000-881-445	5PCS
S 119	WASHER HEAD SCREW *A*	M4 X 12	000-881-146	4PCS
S 120	WASHER HEAD SCREW *B*	M4 X 8	000-881-445	6PCS
S 121	WASHER HEAD SCREW *B*	M4 X 8	000-881-445	6PCS
S 122	PAN HEAD SCREW	M4 X 20	000-861-095	
S 123	WASHER HEAD SCREW *B*	M3 X 6	000-881-403	8PCS
S 124	WASHER HEAD SCREW *A*	M4 X 10	000-881-145	4PCS

NOTE:
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SYMBOL 記号		PARTS NAME 部品名	TYPE/DWG. NO. 型名/図番	CODE NO. コード番号	REMARKS 備考
A	201A	DISPLAY ASSEMBLY	1P1B0-1600U	003-114-230	FOR USA
A	201A	DISPLAY ASSEMBLY	1P1B0-1600A	003-114-240	FOR JAPAN
A	201A	DISPLAY ASSEMBLY	1P1B0-1600S	003-114-220	FOR OTHER THAN JAPAN & USA
A	202A	DISPLAY UNIT *U*		003-113-430	FOR USA
A	202A	DISPLAY UNIT *A*		003-113-440	FOR JAPAN
A	202A	DISPLAY UNIT *S*		003-113-420	FOR OTHER THAN JAPAN & USA
A	203	DISPLAY COVER	03-004-1031-1	300-410-311	
A	204	RAMP BASE	03-004-1011-2	300-410-112	
A	205	MOUNTING CRADLE	03-004-1020-0	300-410-200	
A	206	COVER FIXING METAL	RDAA-0103-1	353-201-031	
A	207	WING KNOB *1*	03-004-1061-0	300-410-610	
A	208	WING KNOB *2*	03-004-1062-0	300-410-620	
A	209	KNOB *SINGLE*	03-004-1064-0	300-410-640	
A	210	KNOB *DOUBLE*	03-004-1065-0	300-410-650	
A	211	KNOB CAP	03-004-1066-0	300-410-660	
A	212	CURSOR KNOB	03-004-1063-0	300-410-630	
A	213	KNOB CAP	03-004-1066-0	300-410-660	
A	214	IDLE GEAR ASSEMBLY	M-1600	003-113-380	
A	215	ROLLER	03-001-1261-1	300-112-611	
A	216	ROLLER	03-001-1261-1	300-112-611	
A	217	CURSOR PANEL	03-004-1201-0	300-412-010	
A	218	HOOD FIXTURE	03-004-1202-2	300-412-022	
A	219	LIGHT SEAL RUBBER *2*	03-004-1203-0	300-412-030	
A	220	CONTROL PANEL	03-004-1221-3	300-412-213	
A	221	RUBBER BUSH *1*	03-004-1222-0	300-412-220	
A	222	RUBBER BUSH *1*	03-004-1222-0	300-412-220	
A	223	RUBBER BUSH *2*	03-004-1223-0	300-412-230	
A	224	CURSOR PLATE	03-004-1231-2	300-412-312	
A	225	LIGHT SEAL RUBBER	03-004-1232-0	300-412-320	
A	226	PINCH ROLLER SUPPORT PLATE	03-004-1241-0	300-412-410	
A	227	CURSOR DRIVING GEAR	03-004-1261-1	300-412-611	
A	228	PCB COVER	03-004-1105-1	300-411-051	
A	229	SW & VR MOUNTING PLATE	03-004-1101-4	300-411-014	
A	230	DISPLAY CHASSIS	M-1600	003-113-360	
A	231	CRT FIXING PLATE ASSEMBLY	M-1600	003-113-400	
A	232	CRT RETENTION RUBBER	R-12028-D	351-500-240	
A	233	CRT SUPPORT METAL	RDZ-1201-1	353-112-011	
A	234	CRT NECK COVER	03-004-1331-1	300-413-311	
A	235	REFLECTION PLATE	03-004-1106-0	300-411-060	
A	236	REFLECTION PLATE	03-004-1106-0	300-411-060	
A	237	MAGNET MOUNT	03-004-1332-0	300-413-320	
A	238	CENTERING MAGNET	RP-4258	000-499-026	
A	239	CENTERING MAGNET	RP-4258	000-499-026	
A	240	SPACER	RP-4259	000-877-120	
A	241	CABLE BLIND PLATE	03-004-1133-1	300-411-331	
A	242	BLIND PLATE	03-004-1132-2	300-411-322	
A	243	SPACER	3MMDIA. X 8	000-877-013	
A	244	SPACER	3MMDIA. X 5	000-877-011	
A	245	SPACER	3MMDIA. X 5	000-877-011	
BT	201	HEXAGONAL HEAD BOLT	M8 X 40 (SUS)	000-862-157	2PCS
BT	202	HEXAGONAL HEAD BOLT	M6 X 20	000-862-131	4PCS
N	201	HEXAGONAL NUT	M6	000-863-109	3PCS
N	202	HEXAGONAL NUT	M6	000-863-109	3PCS
S	201	WASHER HEAD SCREW *A*	M3 X 6	000-881-103	4PCS
S	204	WASHER HEAD SCREW *B*	M3 X 10	000-881-405	2PCS
S	205	PAN HEAD SCREW	M3 X 12	000-861-068	2PCS
S	206	WASHER HEAD SCREW *B*	M3 X 15	000-881-407	
S	207	FILLISTER HEAD SCREW	M4 X 10	000-861-894	4PCS
S	208	WASHER HEAD SCREW *A*	M3 X 6	000-881-103	2PCS
S	209	WASHER HEAD SCREW *B*	M3 X 6	000-881-403	5PCS
S	210	WASHER HEAD SCREW *A*	M3 X 6	000-881-103	4PCS
S	211	WASHER HEAD SCREW *A*	M3 X 6	000-881-103	3PCS
S	212	WASHER HEAD SCREW *B*	M3 X 15	000-881-407	
S	213	SELF TAPPING SCREW	M3 X 6	000-867-581	8PCS
S	214	WASHER HEAD SCREW *A*	M3 X 6	000-881-103	2PCS

NOTE:

備考:

SYMBOL 記号	PARTS NAME 部品名	TYPE/DWG. NO. 型名/図番	CODE NO. コード番号	REMARKS 備考
S 215	WASHER HEAD SCREW *B*	M4 X 10	000-881-446	4PCS
S 216	WASHER HEAD SCREW *A*	M3 X 6	000-881-103	2PCS
S 217	NYLON PUSH RIVET	FNRP 3X5.5 WHITE	000-865-853	5PCS
S 218	WASHER HEAD SCREW *A*	M3 X 6	000-881-103	2PCS
S 219	WASHER HEAD SCREW *B*	M3 X 8	000-881-404	2PCS
S 220	PAN HEAD SCREW	M3 X 25	000-861-121	5PCS
S 221	PAN HEAD SCREW	M4 X 20	000-861-095	
S 222	WASHER HEAD SCREW *B*	M4 X 10	000-881-446	4PCS
S 224	WASHER HEAD SCREW *B*	M3 X 12	000-881-406	
S 225	WASHER HEAD SCREW *A*	M4 X 10	000-881-145	4PCS
S 226	WASHER HEAD SCREW *B*	M3 X 12	000-881-406	
S 227	WASHER HEAD SCREW *B*	M3 X 15	000-881-407	
S 228	SOCKET SET SCREW	M3 X 4	000-861-601	2PCS
S 229	SOCKET SET SCREW	M3 X 4	000-861-601	
S 230	SOCKET SET SCREW	M3 X 4	000-861-601	
S 231	SOCKET SET SCREW	M3 X 4	000-861-601	2PCS
S 232	SOCKET SET SCREW	M3 X 4	000-861-601	2PCS
S 233	SOCKET SET SCREW	M3 X 4	000-861-601	2PCS
S 234	SOCKET SET SCREW	M3 X 4	000-861-601	
S 235	SOCKET SET SCREW	M3 X 4	000-861-601	2PCS

NOTE:

備考:

SYMBOL 記号		PARTS NAME 部品名	TYPE／DWG. NO. 型名／図番	CODE NO. コード番号	REMARKS 備考
A	250A	DEFLECTION TABLE ASSEMBLY	1P1-M-1600	003-114-110	
A	251	DEFLECTION TABLE	03-004-1301-3	300-413-013	
A	252	MOTOR SHIELD CASE *3*	03-001-1304-1	300-113-041	
A	253	MOTOR SHIELD CASE *2*	RDS-3404-1	352-334-041	
A	254	BEARING	SS 8-16ZZ WITH P6	000-875-206	
A	255	BEARING	SS 8-16ZZ WITH P6	000-875-206	
A	256	SHUTTER	03-001-1322-1	300-113-221	
A	257	COIL DRIVING GEAR	03-004-1302-0	300-413-020	
A	258	COIL TURNING GEAR	RDS-3201-4	352-332-014	
A	259	BEARING SHAFT *1*	RDT-3002-0	352-430-020	
A	260	BEARING SHAFT *2*	RDT-3003-0	352-430-030	
BT	251	HEXAGONAL HEAD BOLT	M4 X 20	000-862-115	
S	251	WASHER HEAD SCREW *A*	M3 X 8	000-881-104	4PCS
S	252	WASHER HEAD SCREW *A*	M3 X 6	000-881-103	
S	253	WASHER HEAD SCREW *B*	M4 X 20	000-881-451	2PCS
S	254	WASHER HEAD SCREW *A*	M4 X 6	000-881-143	2PCS
S	255	PAN HEAD SCREW	M3 X 6	000-861-113	
S	256	WASHER HEAD SCREW *A*	M3 X 6	000-881-103	4PCS
S	257	PAN HEAD SCREW	M3 X 10	000-861-115	2PCS
S	258	PAN HEAD SCREW	M3 X 6	000-861-113	
S	259	WASHER HEAD SCREW *A*	M4 X 6	000-881-143	2PCS
S	260	WASHER HEAD SCREW *B*	M3 X 10	000-881-405	2PCS
S	261	SOCKET SET SCREW	M3 X 4	000-861-601	2PCS

NOTE:
備考:

FURUNO

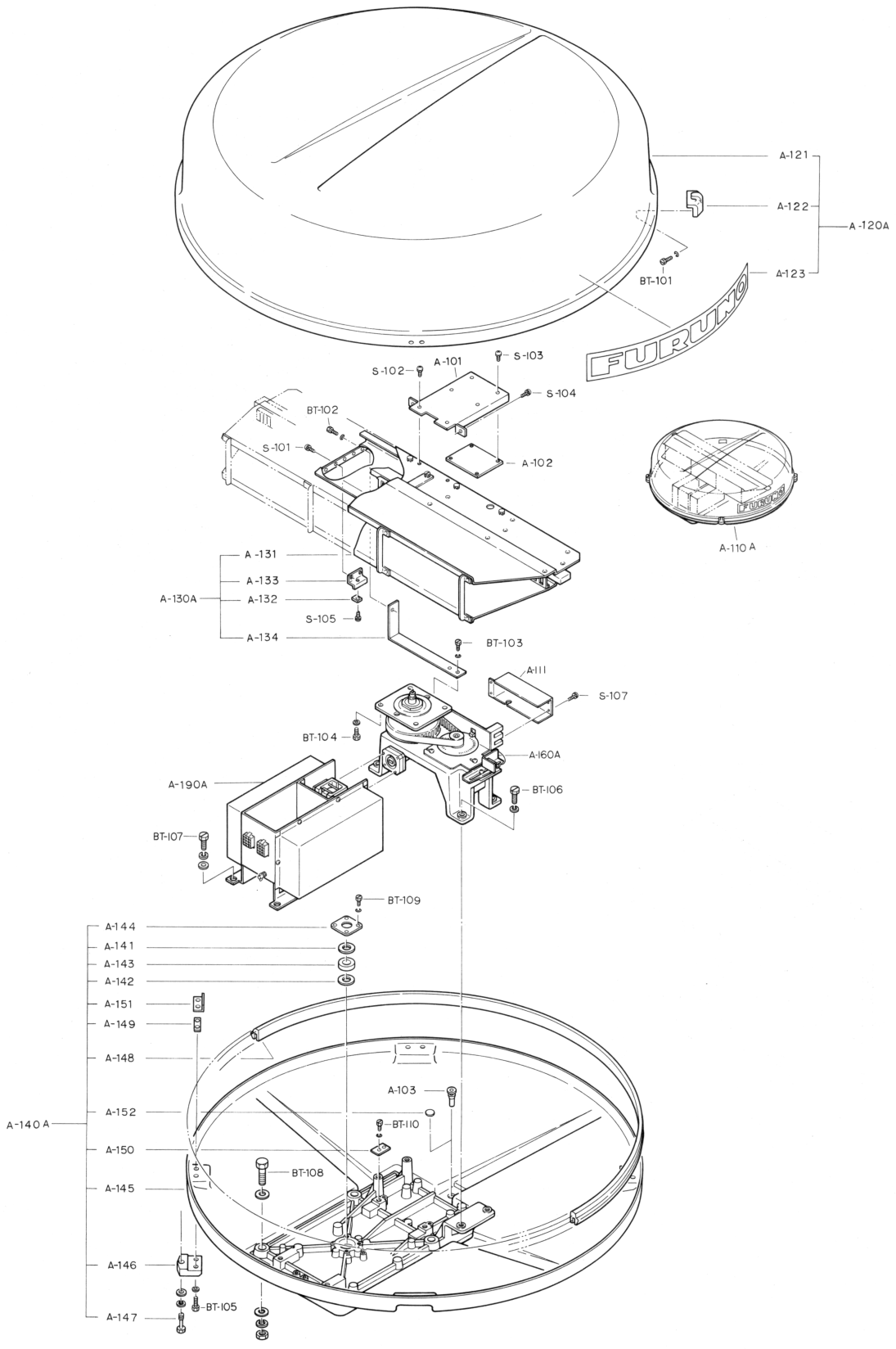
VIEWING HOOD ASSEMBLY
REF. DWG. NO. C3248-006-A

MODEL 1600

SYMBOL 記号	PARTS NAME 部品名	TYPE/DWG. NO. 型名/図番	CODE NO. コード番号	REMARKS 備考
A 2003A	VIEWING HOOD ASSEMBLY	1P1-M1600	003-114-180	
A 401	HOOD *1*	03-004-1601	300-416-010	1910
A 402	HOOD *2*	03-004-1602	300-416-020	
A 403	LENS	RCD-2144-1	351-600-431	
A 404	LENS SUPPORT RUBBER	RDP-8002-0	352-080-020	34.50
A 405	RUBBER VISOR	RDP-8004-1	352-080-041	
A 406	RUBBER VIBRATION ISOLATOR	03-004-1603	300-416-030	6PCS
S 401	PAN HEAD SCREW	M3 X 18	000-861-118	4PCS
W 401	SPRING WASHER	M3	000-864-204	4PCS

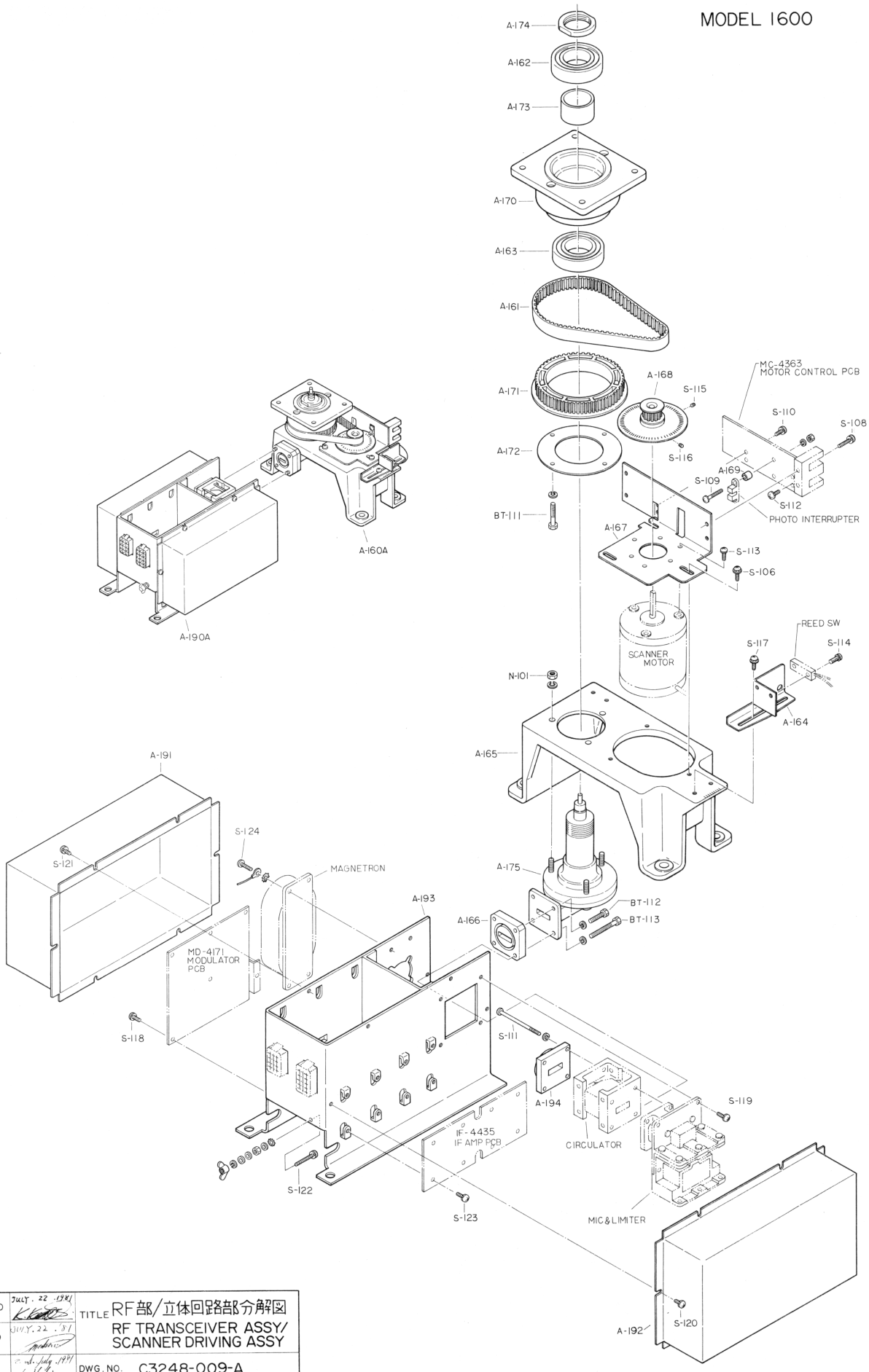
NOTE:
備考:

MODEL 1600



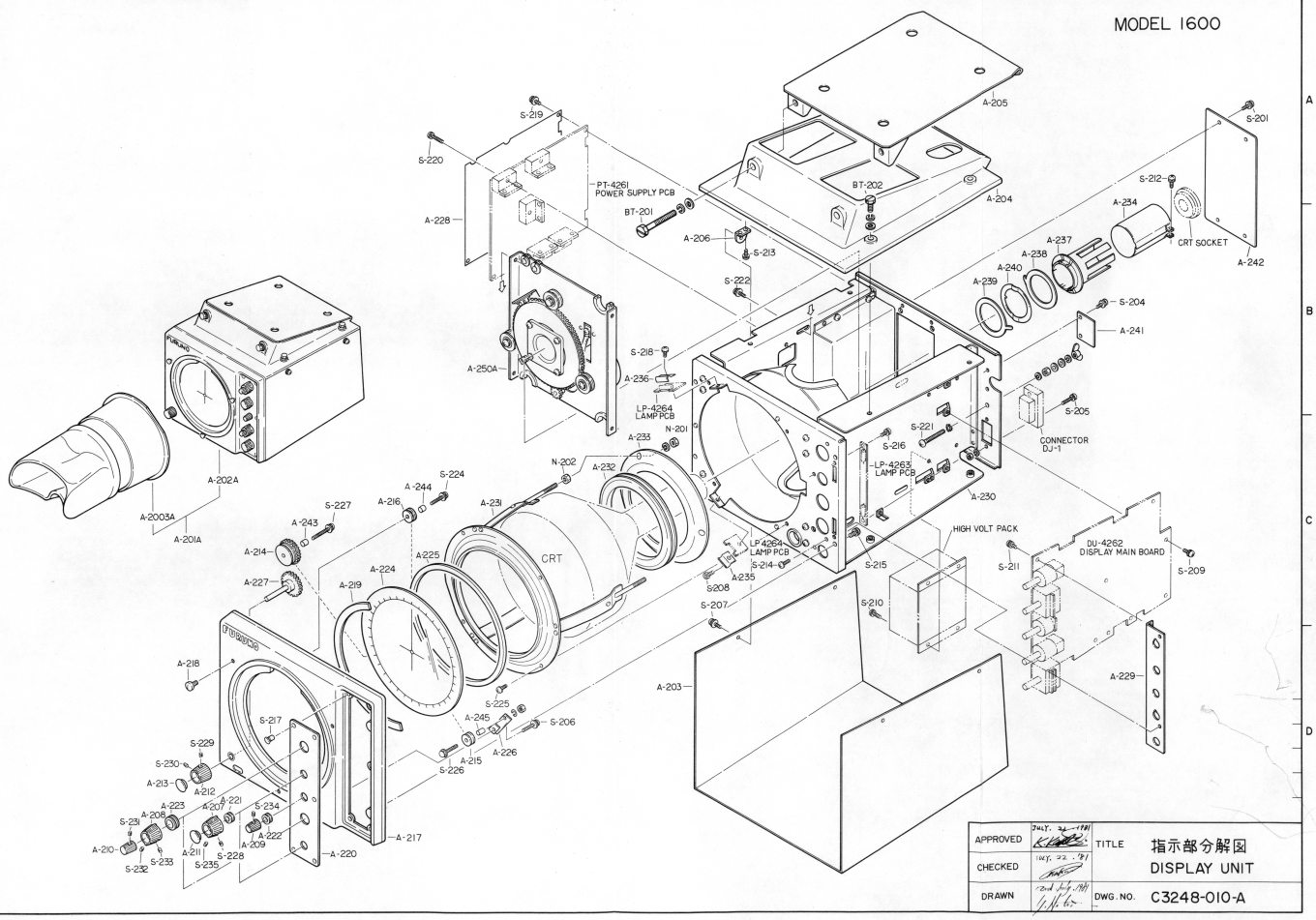
APPROVED	JULY. 23 '1991 K. Kashiwara	TITLE	空中線部分解図
CHECKED	JULY. 22. '91		SCANNER UNIT
DRAWN	read July. 1991	DWG. NO.	C3248-008-A

MODEL 1600



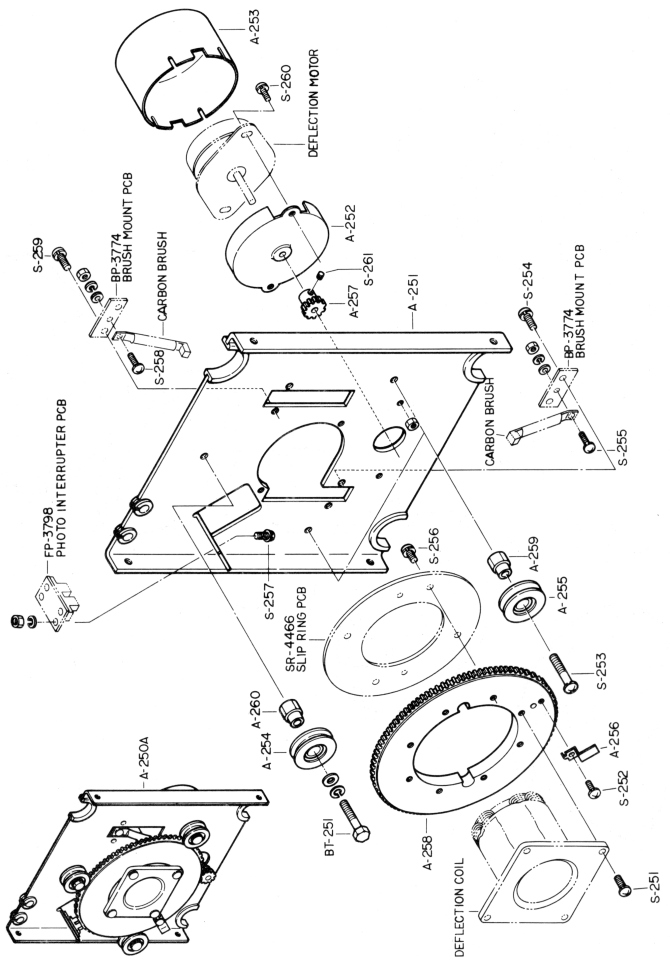
APPROVED	JULY. 22. 1981	TITLE	RF部/立体回路部分解図 RF TRANSCEIVER ASSY/ SCANNER DRIVING ASSY
CHECKED	JULY. 22. '81		
DRAWN	July. 1981	DWG. NO.	C3248-009-A

MODEL 1600



APPROVED	JULY. 24 - 1981	TITLE	指示部分解図
CHECKED	JULY. 22. '81		DISPLAY UNIT
DRAWN	22nd July 1981	DWG. NO.	C3248-010-A

MODEL 1600

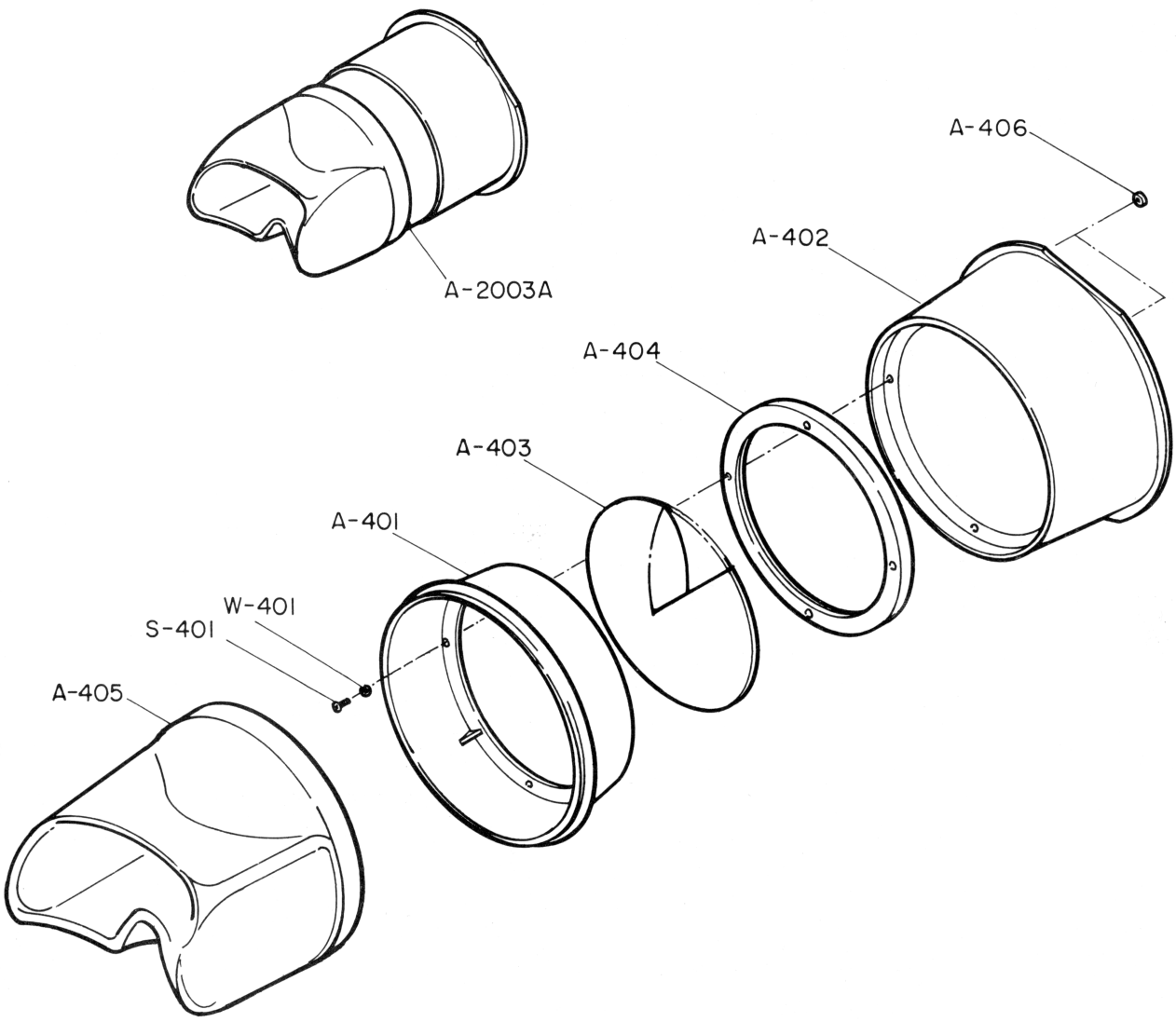


APPROVED	JULY. 23 '81	TITLE	偏向テーブル分解図 DEFLECTION TABLE ASSY
CHECKED	JULY. 22. '81		
DRAWN	22nd. July. 1981	DWG.NO.	C3248-011-A

FURUNO

D - 5

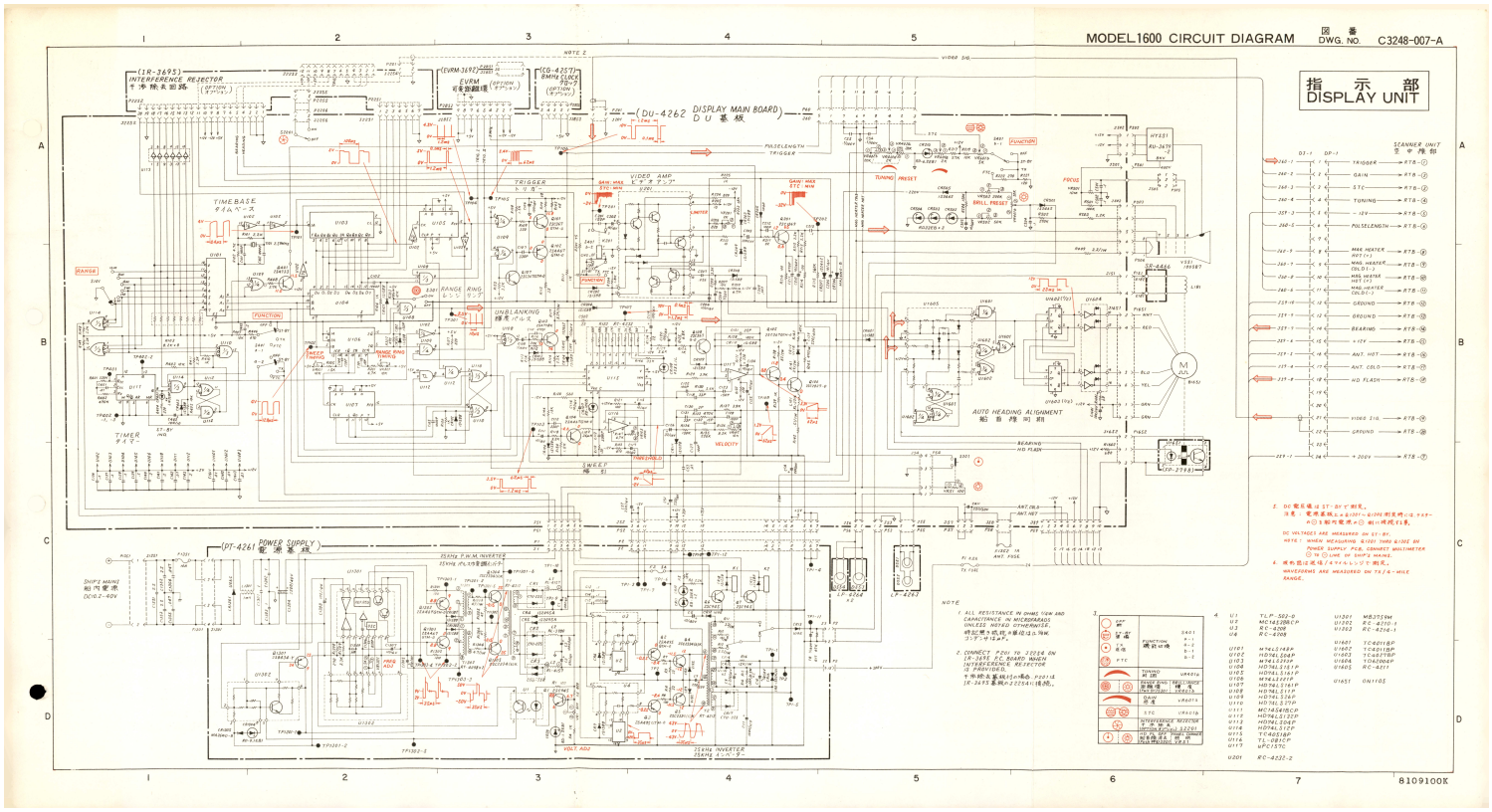
MODEL 1600

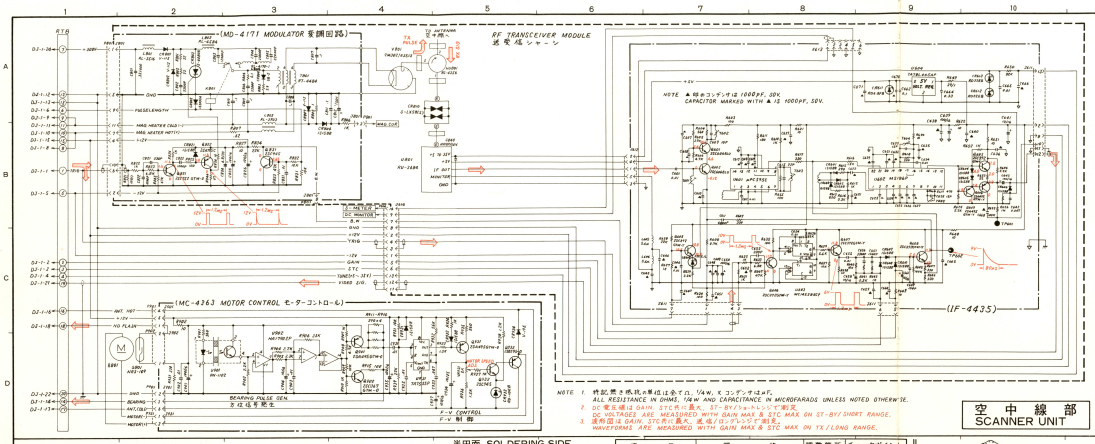


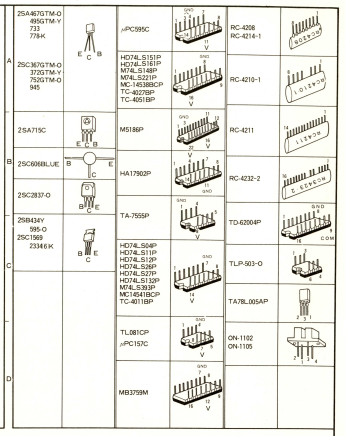
品番 ITEM	品名 NAME	材質 MATERIAL	数量 Q'TY	図番 DWG.NO.	摘要 REMARKS

承認 APPROVED	JUL. 23. '81 K. Kanda	三角法 THIRD ANGLE PROJECTION		名称 TITLE	フード部分解図 VIEWING HOOD ASSEMBLY
検図 CHECKED	JULY. 22. '81	尺度 SCALE	/		
製図 DRAWN	22nd. July. 1981	重量 WEIGHT	kg	図番 DWG.NO.	C3248-006-A

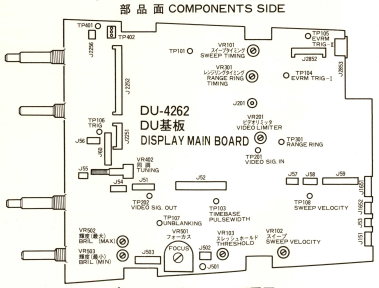
FURUNO ELECTRIC CO., LTD.


MODEL1600 CIRCUIT DIAGRAM
図番 DWG. NO. C3248-007-A
指示部 DISPLAY UNIT
(DU-4262 DISPLAY MAIN BOARD) DU基板
(DT-4261 POWER SUPPLY) 電源基板
(1R-3695) INTERFERENCE REJECTOR 干渉除去回路 (OPTION)
(EVRM-3692) EVRM 可変偏距環 (OPTION)
(EG-4257) 6MHz CLOCK (OPTION)
TIMEBASE タイムベース
TRIGGER トリガ
VIDEO AMP ビデオアンプ
UNBLANKING 輝度パルス
SWEEP 掃引
RANGE RING 距離リング
TIMER タイマー
AUTO HEADING ALIGNMENT 船首線同期
SCANNER UNIT 空中線部
SHIP'S MAIN 船内電源 DC10.2~40V
75kHz P.W.M. INVERTER 75kHz パルス幅変調インバータ
NOTE
1. ALL RESISTANCE IN OHMS 1/4W AND CAPACITANCE IN MICROFARADS UNLESS NOTED OTHERWISE.
特記無き抵抗値は0.25W、コンデンサは μF。
2. CONNECT P201 TO J3214 ON DU-4262 BOARD WHEN INTERFERENCE REJECTOR IS PROVIDED.
干渉除去基板付の場合、P201を DU-4262 基板の J3214 に接続。
8109100K


(MD-4171 MODULATOR 変調回路)
RF TRANSCEIVER MODULE
送受信ユニット
(MC-4363 MOTOR CONTROL モーターコントロール)
(IF-4435)
NOTE 1. 特記無き抵抗の単位は Ω で、1/4W、C コンデンサは μF。
ALL RESISTANCE IN OHMS, 1/4 W AND CAPACITANCE IN MICROFARADS UNLESS NOTED OTHERWISE.
2. DC 電圧値は GAIN、STC 共に最大、ST-BY/ショートレンジで測定。
DC VOLTAGE ARE MEASURED WITH GAIN MAX & STC MAX ON ST-BY/SHORT RANGE.
3. 波形図は GAIN、STC 共に最大、感度/ロングレンジで測定。
WAVEFORMS ARE MEASURED WITH GAIN MAX & STC MAX ON TX/LONG RANGE.
空 中 線 部
SCANNER UNIT

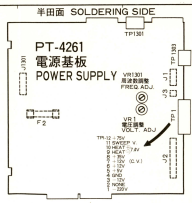


部 品 面 COMPONENTS SIDE

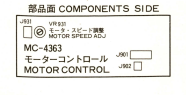


プリセットボリューム配置図 LOCATION OF PRESET POT.

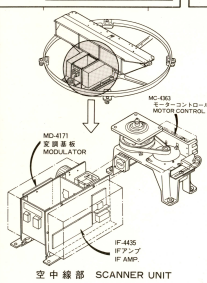
半田面 SOLDERING SIDE



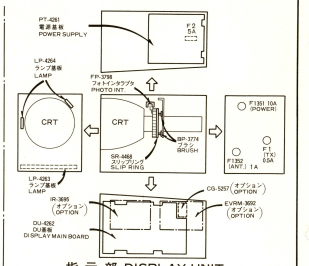
部品面 COMPONENTS SIDE



項 目 ITEMS	規 格 RATINGS	調整箇所 ADJUSTER	チェックポイント CHECK POINTS
スイープ SWEEP VELOCITY	L=74±1mm Z = L / 4 ± 1mm	VR102	CRT
ビデオ・リミッタ VIDEO LIMITER	RANGE RINGS ON SIGNAL. 4 V−38−40V (16M TX, GAIN 1:00−3:00 O'CLOCK)	VR201	TP202
レンジ・リング・タイミング RANGE RING TIMING	1/4, 1/2 リングが同位置に出る事。 1/4&1M RINGS SHOULD APPEAR AT SAME POSITION.	VR301	CRT
フォーカス FOCUS		VR501	CRT
輝 度 (最大) BRILLIANCE (MAX)	輝度ツマミ 1:30〜2:30で適当な明るさで走る事。BRIGHT ENOUGH WITH BRILL SET TO 1:30−2:30'CLOCK.	VR502	CRT
輝 度 (最小) BRILLIANCE (MIN)	輝度ツマミ7:00'で帰ら無い事。NO ECHOES WITH BRILL SET TO 7:00 O'CLOCK.	VR503	CRT
スイープタイミング SWEEP TIMING (VR101) 受信部同調 (VR402) COARSE TUNING	"装備要領" を参照 REFER TO "INSTALLATION INSTRUCTION"		
インバータ INVERTER 周波数 FREQ 定電圧 VTG	24.75−25.25KHz 11.68−11.92V	VR1301 VR1	TP1303 ≒1−≒4 TP1 ≒7ハ−≒4ム
モーター・スピード MOTOR SPEED	180±2Hz	VR931	J901 ≒3



空 中 線 部 SCANNER UNIT



指 示 部 DISPLAY UNIT

基板配置図 PCB LOCATION